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NATIONAL DAM SAFETY PROGRAM, STAR LAKE UPPER DAM (NJ00221), DEL--ETC(U)
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DELAWARE RIVER BASIN
TRIBUTARY TO PEQUANNOCK RIVER
PASSAIC COUNTY
NEW JERSEY

STAR LAKE UPPER DAM
NJ 00221

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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FEBRUARY 1980

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Dams
Embankments
Visual Inspection
Structural Analysis
National Dam Safety Program
Star Lake Upper Dam, New Jersey
Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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NOTICE

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

28 JUL 1980

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Star Lake Upper Dam in Passaic County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Star Lake Upper Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 15 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard of loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within twelve months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Design and oversee procedures for the removal of trees from the upstream slope of the dam.

(2) Design and oversee the installation of erosion protection for the upstream slope of the dam.

(3) Evaluate the potential for erosion and undermining of the downstream toe of the dam if water is discharged from the outlet pipe near the left abutment.

(4) Investigate the cause of the leakage that is discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment, and design remedial measures if needed.

Initiate any recommended remedial action within three months of study completion.

c. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

d. Within six months from the date of approval of this report, the following remedial actions should be initiated:

(1) Establish grassy vegetation on the embankment.

(2) Clean and paint the rusted steel member embedded in the spillway crest and rusted portions of the service bridge.

(3) Repair spalled and eroded concrete surfaces of the spillway abutments and stone-masonry wall caps.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Roe of the Eighth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

STAR LAKE UPPER DAM (NJ0221)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 8 November 1979, by Anderson-Nichols & Co., Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Star Lake Upper Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 15 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard of loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within twelve months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Design and oversee procedures for the removal of trees from the upstream slope of the dam.

(2) Design and oversee the installation of erosion protection for the upstream slope of the dam.

(3) Evaluate the potential for erosion and undermining of the downstream toe of the dam if water is discharged from the outlet pipe near the left abutment.

(4) Investigate the cause of the leakage that is discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment, and design remedial measures if needed.

Initiate any recommended remedial action within three months of study completion.

c. Within one year from the date of approval of this report the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

d. Within six months from the date of approval of this report, the following remedial actions should be initiated:

(1) Establish grassy vegetation on the embankment.

(2) Clean and paint the rusted steel member embedded in the spillway crest and rusted portions of the service bridge.

(3) Repair spalled and eroded concrete surfaces of the spillway abutments and stone-masonry wall caps.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 20 JUN 80

(9) Final rept. (10) Warren Guinan (11) Feb 80

(15) DACW61-79-C-0011

(6) PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Star Lake Upper Dam
Identification No.: Fed ID No. (NJ00221)
State Located: New Jersey
County Located: Passaic
Stream: Tributary to Pequannock River
River Basin: Passaic
Date of Inspection: November 8, 1979

ASSESSMENT OF GENERAL CONDITIONS

Star Lake Upper Dam is about 80 years old and in good overall condition. It is small in size and is classified as High Hazard. The crest of the dam consists of concrete cap walls on upstream and downstream faces with a bare dirt path in between. Trees up to 5 inches in diameter are growing on the crest and upstream face of the dam. The riprap on the upstream face is in poor condition. There is some rusting and erosion of the embedded steel member in the spillway crest and steel of the service bridge. There is also some spalling of the spillway abutments. Some leakage is discharging from the dry stone-masonry on the downstream side of the dam near the right abutment. The spillway can pass approximately 14 percent of the PMF and is inadequate.

It is recommended that the owner retain the services of a professional engineer, qualified in the design and construction of dams, to accomplish the following in the future: design and oversee procedures for the removal of trees and their root system from the upstream slope of the dam; design and oversee the installation of erosion protection for the upstream slope of the dam; evaluate the potential for erosion and undermining of the downstream toe of the dam if water is discharged from the outlet pipe near the left abutment; investigate the cause of the leakage that is discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment, and design remedial measures if needed; and conduct a more detailed hydrologic and hydraulic analysis of the watershed, reservoir, dam and spillway to determine the extent and type of remedial measures necessary.

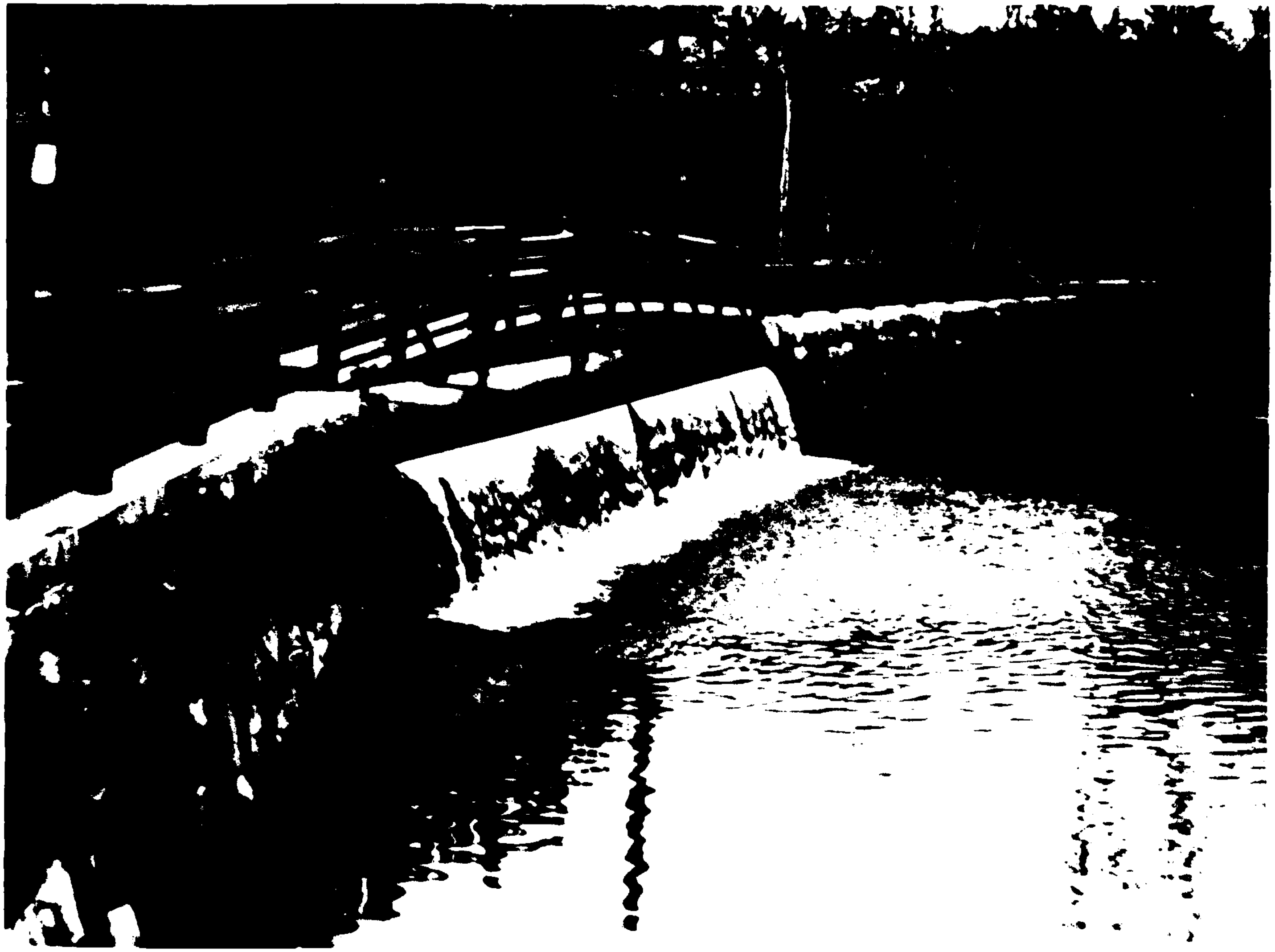
It is further recommended that the owner accomplish the following tasks as a part of operating and maintenance procedures: in the near future, establish a surveillance program for use during and immediately after periods of heavy rainfalls, and also a warning system to follow in case of emergency conditions; establish grassy vegetation on the embankment; clean and paint the rusted steel imbedded members; and repair spalled and eroded concrete surfaces of the spillway abutments and stone masonry wall caps. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

ANDERSON-NICHOLS & COMPANY, INC.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
New Jersey No. 16848

410871



November 8, 1979

OVERVIEW
Star Lake Upper Dam

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY REPORT

STAR LAKE UPPER DAM FED ID NO. NJ00221 N.J. 22-52

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION PROGRAM
STAR LAKE UPPER DAM
FED ID No. #NJ00221 NJ No. #22-52

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Star Lake Upper Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 26 October 1979 under Contract No. FPM-39 dated 28 June 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc. on 5 November 1979.

b. Purpose. The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to the safety of Star Lake Upper Dam and appurtenances based upon available data and visual inspection, and determine any need for emergency measures and conclude if additional studies, investigations, and analyses are necessary and warranted.

1.2 Project Description

a. Description of Dam and Appurtenances. Star Lake Upper Dam is a 200-foot long earthfill and stone masonry dam with a hydraulic height of 10 feet and structural height of 10.5 feet. The downstream face is of stone masonry with a vertical slope and the upstream face is of earth and rock with a 1H:1V slope. The 52-foot long concrete free overflow spillway is near the center of the dam. A bridge extends along the crest of the dam. There are 25-foot long and 11-foot long 18-inch diameter concrete pipe low-level outlets located on west (right) and east (left) abutments respectively, about 2 feet above the toe of the embankment. Operating mechanisms for the low-level outlets are located on the upstream slope of the embankment a few feet upstream of the normal water line. Essential features of the dam are given in Figure 1.

b. Location. The dam is located in Passaic County, New Jersey on a tributary to the Pequannock River, approximately 1.5 miles north of Bloomingdale. It is a north latitude 41° 1'4' and west longitude 74°21.0'. A location map is given in Figure 2.

c. Size Classification. Star Lake Upper Dam is classified as being small in size on the basis of storage at the dam crest of 150 acre-feet, which is less than 1000 acre-feet but more than 50 acre-feet, and on the basis of its height of 10 feet, which is less than

40 feet, in accordance with criteria given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Visual inspection of the downstream area and the breach analysis contained herein show that failure of Star Lake Upper Dam would lead to the overtopping of Star Lake Lower Dam downstream, which could lead to severe damage to three structures just downstream of Star Lake Lower Dam and possible loss of more than a few lives (downstream area is a camp and the structures are used part of the year). Star Lake Upper Dam is thus classified as High Hazard.

e. Ownership. The dam is owned by the Salvation Army. Captain Israel Gaither, 546 Avenue of the Americas, New York, New York, 10011, (212) 255-9400 is the responsible party.

f. Purpose of Dam. The lake is used for recreation.

g. Design and Construction History. No information was found regarding the original design and construction of the dam which took place around 1900.

h. Normal Operational Procedures. The lake level is lowered every fall to protect the docks from ice.

i. Site Geology. No site specific geologic information (such as borings) was available at the time the dam was inspected. Information derived from a report entitled "Engineering Geology of the Northeast Corridor, Washington, D.C. to Boston, MA" and the Geologic Map of New Jersey (Lewis and Kummel, 1912) indicate that soils within the immediate site area consist of ground moraine overlying bedrock. Bedrock was observed in extensive outcrops located at the right abutment and adjacent hillside during inspection of this dam. The previously mentioned report indicates that bedrock in this area consists of granitoid gneiss with occasional migmatite, granulite, amphibolite and granitic rocks of Precambrian age.

1.3 Pertinent Data

a. Drainage Area

1.10 square miles

b. Discharge at Damsite (cfs)

Maximum flood at damsite - unknown

Low-level outlets at spillway crest elevation (if operable) - 35.7

Total ungated spillway capacity at maximum pool elevation - 334

c. Elevation (NGVD)

Top of dam - 531.6

Design surcharge (½ PMF) - 533

Recreation pool (at time of inspection) - 530

Spillway crest - 529.9

Streambed at centerline of dam - 521.6

Maximum tailwater (estimated) - 527.1

d. Reservoir (feet)

Length of maximum pool - 1900

Length of recreation pool - 1500

e. Storage (acre-feet)

Recreation pool - 115

Design surcharge (½ PMF) - 183

Top of dam - 150

f. Reservoir Surface (acres)

Top of dam - 21.5

Spillway crest - 16.5

g. Dam

Type - earthfill stone masonry

Length - 200 feet

Height - 10 feet (hydraulic)

- 10.5 feet (structural)

Top width - 5 to 10 feet

Side slopes - upstream 1H:1V, downstream vertical

Zoning - unknown

Impervious core - unknown

Cutoff - unknown

Grout curtain - unknown

h. Spillway

Type - free overflow

Length of weir - 52'

Crest elevation - 529.9' NGVD

Gates - none

U/S Channel - Star Lake Upper

D/S Channel - Star Lake Lower

i. Regulating Outlets

Type - two 18-inch diameter concrete low-level outlet pipes

Length (estimated) - 12 and 25 feet

Access - on upstream slope of embankment a few feet from shore at normal pool

SECTION 2
ENGINEERING DATA

2.1 Design

No plans, hydraulic or hydrologic data for Star Lake Upper Dam were found.

2.2 Construction

No recorded data concerning construction of Star Lake Upper Dam were disclosed. Reference data on file with the New Jersey Department of Environmental Protection indicates that the dam was built in 1900 by Star Safety Razor Company. The date on the left, low-level gate operating structure indicates that it was added to the dam in 1970.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. A search of the New Jersey Department of Environmental Protection files, and contact with the owner revealed only a limited amount of recorded information.

b. Adequacy. Because of the limited amount of recorded data available, evaluation of this dam was based solely on visual observations.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. Dam. Trees are growing on the upstream slope of the dam. There appear to be remnants of riprap on the upstream slope, but it is in poor condition and there is very little riprap above the waterline. Some leakage is discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment. There is no vegetation on the crest of the dam between the concrete cap walls on the upstream and downstream edges of the crest. There is no vegetation on the embankment next to the left abutment.

b. Appurtenant Structures. Discharge from the low-level outlet pipe near the left abutment is channeled along the downstream toe of the dam at the base of the dry stone-masonry wall which constitutes the downstream side of the dam. It is not possible to determine on the basis of the visual inspection whether there is any potential for erosion and undermining of the wall when water is flowing in this channel.

There is some rusting and erosion of the imbedded steel member in the spillway crest, and some spalling of the spillway abutment. Portions of the service bridge exhibit minor rust.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No formal operating procedures were found. The low-level outlet gates are opened every fall.

4.2 Maintenance of Dam

No formal maintenance procedures for the dam were found

4.3 Maintenance of Operating Facilities

No formal maintenance procedures for operating facilities were found.

4.4 Warning System

No description of any warning system was found.

4.5 Evaluation of Operational Adequacy

Because of the lack of operation and maintenance procedures, the remedial measures described in Section 7.2 should be implemented as prescribed.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. Design Data. Since no data were disclosed an evaluation could not be performed.

b. Experience Data. No experience data were found.

c. Visual Observations. No visual evidence was found of damage to the structure caused by overtopping. At the time of inspection approximately 0.1 foot of water was passing over the free overflow spillway.

d. Overtopping Potential. The hydraulic/hydrologic evaluation for Star Lake Upper Dam is based on a Spillway Design Flood (SDF) equal to one-half the Probable Maximum Flood (PMF) in accordance with the range of test floods given in the evaluation guidelines for dams classified as high hazard and small in size. The effects of Lake Kampfe, immediately upstream, were considered in the analysis. The PMF has been determined by application of the SCS Dimensionless Unit Hydrograph procedure to a 24-hour probable maximum storm of 22 inches. Hydrologic computations are given in Appendix 3. The routed half-PMF peak discharge for the subject watershed is approximately 2200 cfs. The minimum elevation of the dam allows 1.7 feet of depth in the spillway before overtopping occurs. Under this head the spillway capacity is 334 cfs, which is less than the selected SDF.

Flood routing calculations indicate that Star Lake Upper Dam will be overtopped for more than 6 hours to a maximum depth of 1.48 feet under half-PMF conditions. It is estimated that the spillway can pass about 14 percent of the PMF without overtopping the dam, thus the spillway is considered inadequate.

Because the dam was classified as High Hazard based on visual observation, a breach analysis was performed to assess the increase in downstream hazard dam failure conditions. The results of the breach analysis, contained in Appendix 3, show that the downstream hazard is clearly high but is not increased under dam failure conditions.

e. Drawdown Capability. Assuming that the low-level outlet currently in place is in operable condition, it is estimated that the lake can be drained in approximately 1.5 days assuming no significant inflow. This time period is considered adequate for draining the reservoir in an emergency situation.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Trees growing on the crest of the dam may cause seepage and erosion problems if they blow over and pull out their roots or if they die or are cut and their roots rot. The poor condition of the riprap on the upstream slope makes the slope susceptible to erosion. Leakage discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment may lead to a long-term stability problem. The lack of vegetation on the crest of the dam, at the right end of the dam, and on the entire embankment at the left abutment of the dam makes those areas susceptible to erosion if the dam should be overtopped. There is a possibility that if water discharges from the low-level outlet pipe at the left end of the dam, it may cause erosion or undermining of the dry stone-masonry wall on the downstream side of the dam. Based on the visual inspection alone, it is not possible to determine the character of the dam foundation or the interior of the cross section. Therefore, it is not possible to evaluate the factor of safety of the dam against slope failure, sliding, or overturning.

b. Design and Construction Data. No design or construction data pertinent to the structural stability of the dam are available.

c. Operating Records. No operating records pertinent to the structural stability of the dam are available.

d. Post-Construction Changes. No record of post-construction changes pertinent to the stability of the dam is available. The date on the left low-level outlet indicates it was added in 1970.

e. Seismic Stability. This dam is in Seismic Zone 1. According to the Recommended Guidelines, dams located in Seismic Zone 1 "may be assumed to present no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist". None of the visual observations made during the inspection are indicative of unstable slopes. However, because no data are available concerning the engineering properties of the embankment and foundation materials for this dam, it is not possible to make an engineering evaluation of the stability of the slopes or the factor of safety under static conditions.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Star Lake Upper Dam is 80 years old and is in good condition.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection.

c. Urgency. The recommendations made in Sections 7.2 should be implemented by the owner as prescribed below.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.2 a. below. These problems require the attention of a professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures to rectify the problems. The two lakes located upstream and downstream of Star Lake Upper Dam must be considered in this analysis. If left unattended, the problems could lead to failure of the dam.

7.2 Recommendations/Remedial Measures

a. Recommendations. The owner should retain a professional engineer qualified in the design and construction of dams to do the following things in the future:

(1) Design and oversee procedures for the removal of trees and their root systems from the upstream slope of the dam.

(2) Design and oversee the installation of erosion protection for the upstream slope of the dam.

(3) Evaluate the potential for erosion and undermining of the downstream toe of the dam if water is discharged from the outlet pipe near the left abutment.

(4) Investigate the cause of the leakage that is discharging from the dry stone-masonry wall on the downstream side of the dam near the right abutment, and design remedial measures if needed.

(5) Conduct a more detailed hydrologic and hydraulic analysis of the watershed, reservoir, dam, and spillway to determine the extent and type of remedial measures necessary.

The owner should accomplish the following in the near future:

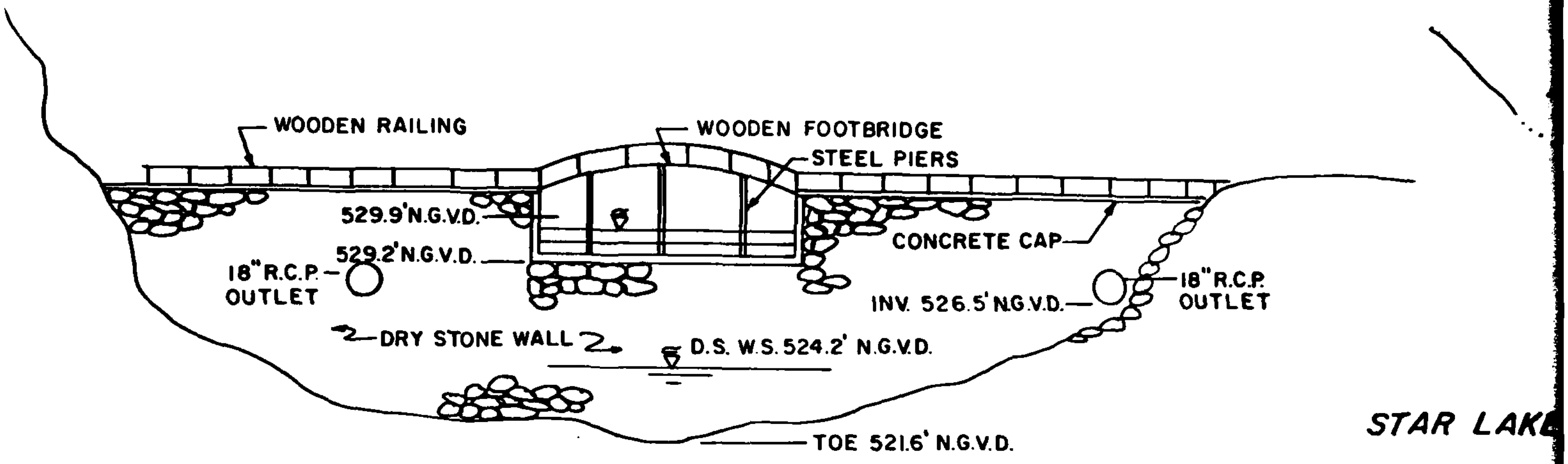
1) Establish a surveillance program for use during and immediately after periods of heavy rainfall, and also a warning system to follow in case of emergency conditions.

2) Establish grassy vegetation on the embankment.

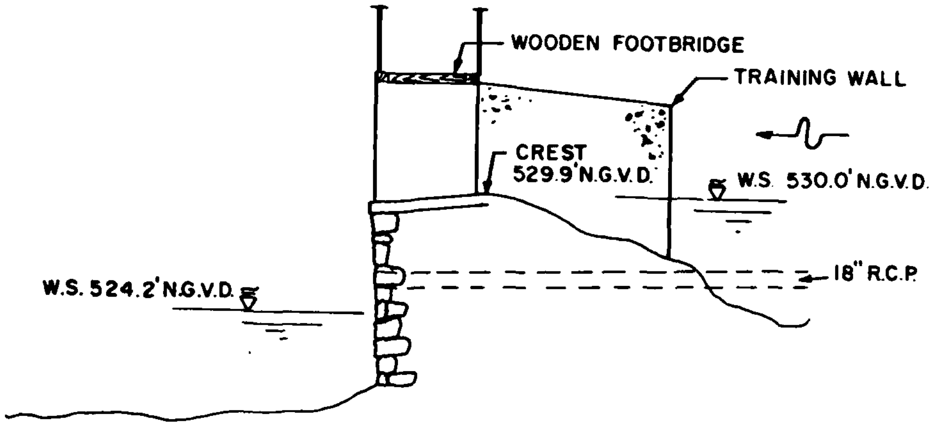
3) Clean and paint the rusted steel member embedded in the spillway crest and rusted portions of the service bridge.

4) Repair spalled and eroded concrete surfaces of the spillway abutments and stone-masonry wall caps.

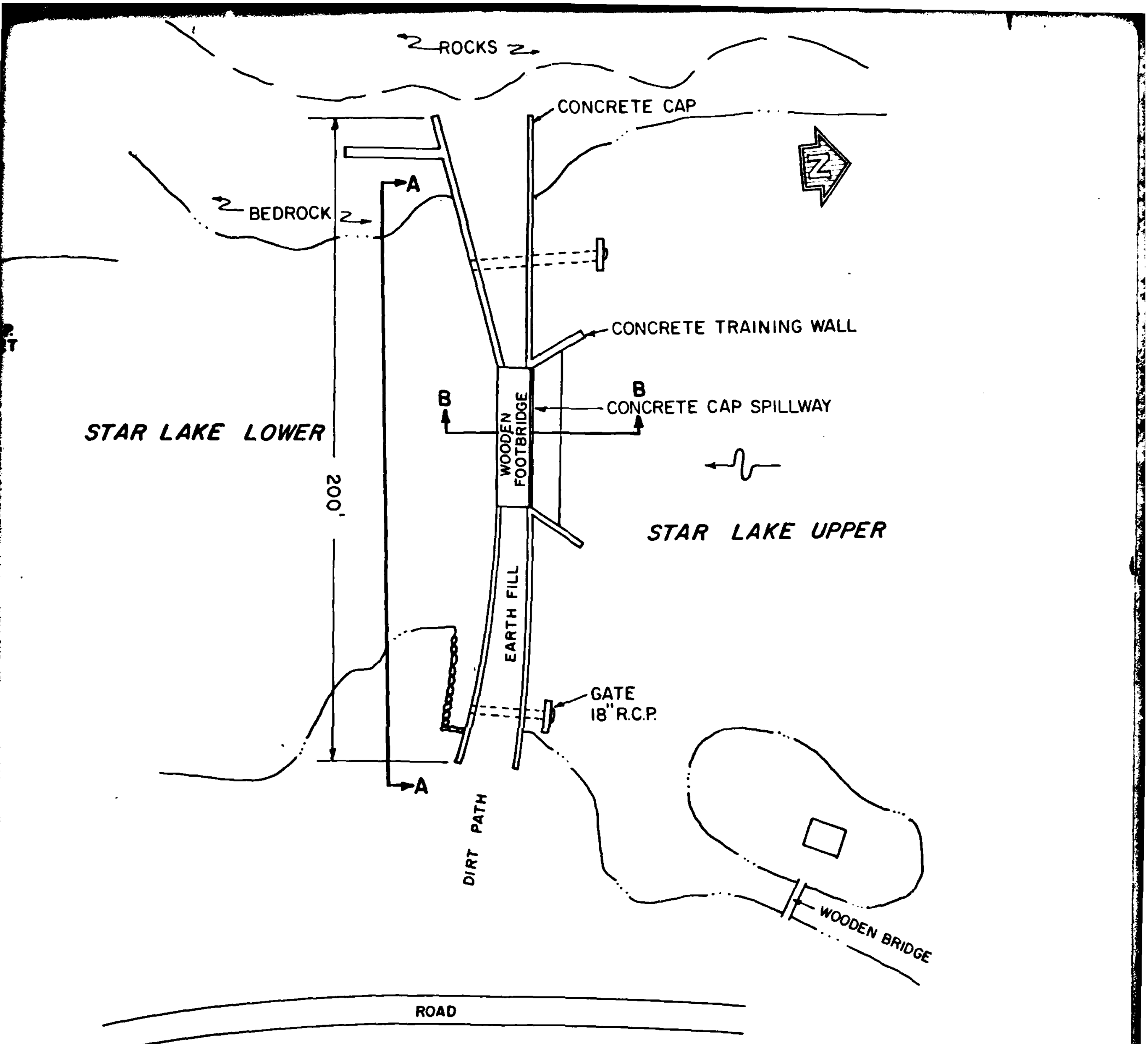
Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.



ELEVATION A-A



SECTION B-B



PLAN

DRAWN FROM FIELD INSPECTION DATA 11/8/79

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

STAR LAKE UPPER DAM

TRIBUTARY TO PEQUANNOCK BROOK NEW JERSEY

SCALE: NOT TO SCALE
DATE: JANUARY 1980

FIGURE-1

2

Anderson-Nichols & Co., Inc.

CONCORD NEW HAMPSHIRE

U.S. ARMY ENGINEER DIST. PHILADELPHIA
CORPS OF ENGINEERS
PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SCALE IN MILES

0 5 10

STAR LAKE UPPER DAM
LOCATION MAP

MAP BASED ON STATE OF NEW JERSEY OFFICIAL HIGHWAY MAP AND GUIDE.

TRIBUTARY TO PEQUANNOCK RIVER NEW JERSEY

SCALE: SEE BAR SCALE

DATE: JANUARY 1980

FIGURE - 2

APPENDIX 1

VISUAL INSPECTION

CHECKLIST

STAR LAKE UPPER DAM

Check List
Visual Inspection
Phase 1

Name Dam Star Lake Upper Dam County Passaic State NJ Coordinators NJDEP

Date(s) Inspection Nov. 8, 1979 Weather cloudy, cool Temperature 60° F

Pool Elevation at Time of Inspection 530' NGVD Tailwater at Time of Inspection 524.2' NGVD

Inspection Personnel:

Warren Guinan	Ronald Hirschfeld
Stephen Gilman	
Janusz Czyzowski	

Gilman/Hirschfeld Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Concrete capped stone-masonry, several cracks in concrete cap. No significant indication of movement.	Repair and seal cracks.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Bare ground and erosion of both upstream and downstream sides of embankment at left abutment.	Repair erosion and provide adequate erosion protection.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good.	
RIPRAP FAILURES	Remnants of riprap below water level on upstream slope appear to be in poor condition. Limited amount of riprap above water level. Small trees growing on upstream edge of crest.	Remove trees and provide adequate erosion protection on upstream slope.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RAILINGS		
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good. (See also "Sloughing or Erosion..." above.)	
ANY NOTICEABLE SEEPAGE	One minor seepage from downstream dry masonry wall near right abutment.	Investigate and implement remedial measures if necessary.
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Good condition-surface erosion of surface laitance of concrete. Steel channel weir embeded in concrete is rusted and corroded. Right training wall at spillway abutment is spalled and eroded.	Clean and paint rusted steel. Repair spalled concrete.
APPROACH CHANNEL	Wide and unobstructed.	
DISCHARGE CHANNEL	Discharge passes directly into small pond which is impounded by another dam immediately downstream.	
BRIDGE AND PIERS OVER SPILLWAY	Good condition. Some surface rust on steel columns and beams. Minor weathering of deck.	Clean and paint areas showing rust.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT		
INTAKE STRUCTURE	Not visible.	
OUTLET PIPE	Left end - major crack on top of pipe.	Monitor - if crack worsens it should be repaired.
OUTLET CHANNEL	Discharge passes directly into small pond which is impounded by another dam immediately downstream.	
EMERGENCY GATE	Left gate - not visible, no leakage observed in outlet pipe. Operating mechanism is in good condition. Right gate - not visible, gate operating mechanism is in good condition.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately to steeply sloping and wooded.	
SEDIMENTATION	No evidence of significant sedimentation observed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wide, an unobstructed spillway drains directly into Star Lake Lower.	
SLOPES	General area in vicinity of lower pond is flat.	
APPROXIMATE NO. OF HOMES AND POPULATION.	Three camp buildings - population varies with season.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	None found
REGIONAL VICINITY MAP	Prepared for this report.
CONSTRUCTION HISTORY	None found
TYPICAL SECTIONS OF DAM	None.
HYDROLOGIC/HYDRAULIC DATA	None.
OUTLETS - PLAN	None.
- DETAILS	None found
- CONSTRAINTS	None found
- DISCHARGE RATINGS	None found
RAINFALL/RESERVOIR RECORDS	None found

ITEM	REMARKS
DESIGN REPORTS	None found
GEOLOGY REPORTS	None found
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None found
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None found
POST-CONSTRUCTION SURVEYS OF DAM	None found
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SERVICES	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	Prepared for this report from field inspection.
DETAILS	None.
OPERATING EQUIPMENT	Two gate valves.
PLANS & DETAILS	None.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mountainous, heavy forest

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 530' NGVD (115)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not applicable

ELEVATION MAXIMUM DESIGN POOL: 533' NGVD

ELEVATION TOP DAM: 531.6' NGVD

CREST: Free overflow concrete capped spillway.

a. Elevation 529.9' NGVD

b. Type concrete weir

c. Width 6 feet

d. Length 52 feet

e. Location Spillover center of the dam

f. Number and Type of Gates

OUTLET WORKS: Two low-level outlet pipes

a. Type 18-inch diameter concrete pipes

b. Location on right and left abutments

c. Entrance Inverts Unknown

d. Exit Inverts 826.5' NGVD

e. Emergency Draindown Facilities (described above)

HYDROMETEORLOGICAL GAGES: None

a. Type

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 334 cfs

APPENDIX 2

PHOTOGRAPHS

STAR LAKE UPPER DAM

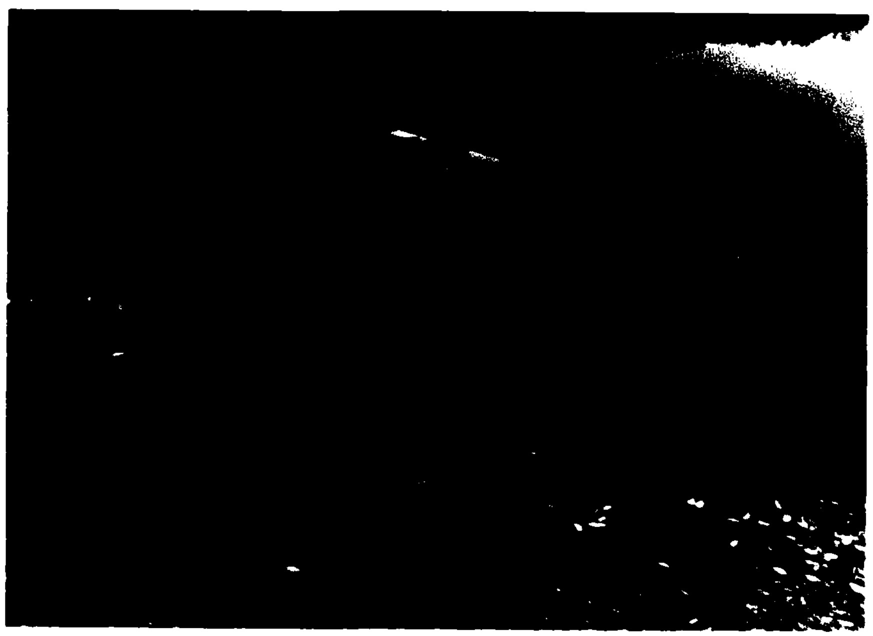
November 8, 1979
View of the crest of the dam from left abutment looking west.

November 8, 1979
View of the crest of the dam from right abutment looking east.

November 8, 1979
View of the upstream face of the free overflow spillway.

November 8, 1979
View of the upstream reservoir from the dam crest.

November 8, 1979
Upstream face of the dam from left embankment.



November 8, 1979
View of the low-level outlet gate on the left of the spillway from left embankment.

November 8, 1979
View of the low-level outlet gate on the right of the spillway from dam crest.

November 8, 1979
Low-level outlet of the left abutment.

November 8, 1979
Seepage at the downstream face of right abutment.

November 8, 1979
View of the junction of the right training wall and the spillway showing spalling of the concrete on the surface.

November 8, 1979
View of the downstream channel from the dam crest.

APPENDIX 3

HYDROLOGIC COMPUTATIONS

STAR LAKE UPPER DAM

Anderson-Nichols & Company, Inc.

JOB NO. 3409-09

Subject STAR LAKE UPPER DAM

Sheet No. 1 of

Date 11-28-79

Computed [illegible]

Checked [illegible]

SQUARES 1/4 IN SCALE

HYDROLOGIC COMPUTATIONS

NAME: STAR LAKE UPPER DAM

LOCATION: PASSAIC COUNTY, N.J.

DRAINAGE AREA: 1.10 Mi^2

SURFACE AREA (NORMAL POOL): 16.5 ac

EVALUATION CRITERIA:

SIZE: SMALL

HAZARD: HIGH

SPILLWAY DESIGN FLOOD: BASED ON SIZE AND CLASSIFICATION, THE SPILLWAY DESIGN FLOOD WILL BE THE ½ PMF (½ THE PROBABLE MAXIMUM FLOOD) WITH A PEAK INFLOW OF 2438 CFS.

~~NOTE: DRAINAGE AREA AND SURFACE AREA~~ OF STAR LAKE UPPER DAM WERE PLANIMETERED.

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER DAM

Sheet No. ______ of ______
Date 1/10/80
Computed MHM
Checked TDD

JOB NO. 3409-09

SQUARES 1/4 IN. SCALE

BESIDES STAR LAKE UPPER THERE IS KAMPFE LAKE LOCATED UPSTREAM, WITHIN STAR LAKE UPPER DAM DRAINAGE AREA, WHICH OCCUPIES 0.86 mi^2 OF THE TOTAL 1.10 mi^2 DRAINAGE AREA. USING THE HEC-1 PROGRAM AN INFLOW HYDROGRAPH WAS DETERMINED AND ROUTED THROUGH THE KAMPFE LAKE TO DETERMINE THE OUTFLOW FROM KAMPFE LAKE DAM. THIS OUTFLOW COMBINED WITH INFLOW HYDROGRAPH OF STARLAKE UPPER DAM DRAINAGE AREA (0.24 mi^2) COMPROMISES THE TOTAL INFLOW INTO THE STAR LAKE UPPER.

TIME OF CONCENTRATION

1- SCS TR #55 METHOD:

a) OVERLAND FLOW

LENGTH = 2550 FT

HEAD = 1100 − 740 = 360 FT

$$SLOPE = \frac{360}{2550} = 0.14 = 14\%$$

FROM FIGURE 3-1, PAGE 3-2

VELOCITY = 0.9 FT/SEC

$$T_C = \frac{2550 \text{ FT}}{0.9 \text{ FT/SEC}} = 2833 \text{ SEC} = 47 \text{ MIN}$$

b) CHANNEL FLOW

LENGTH = 2750 FT

~~HEAD = 740 − 540 = 200 FT~~

$$SLOPE = \frac{200}{2750} = 0.073 = 7.3\%$$

~~HYDRAULIC RADIUS = 0.83 FT~~
~~(ASSUME A 10'x1' RECTANGULAR CHANNEL)~~

USE MANNING'S EQUATION:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

WHERE *n = 0.04 (FROM "OPEN CHANNEL HYDRAULICS" BY CHOW)

$$V = \frac{1.49}{0.04}(0.83)^{2/3}(0.073)^{1/2} = 8.9 \text{ FT/SEC}$$

$$T_C = \frac{2750 \text{ FT}}{8.9 \text{ FT/SEC}} = 309 \text{ SEC} = 5.1 \text{ MIN}$$

$$\text{TOTAL } T_C = 47 + 5.1 = \underline{\underline{52.1}} \text{ MIN}$$

2 _ SOIL & WATER CONSERVATION ENGINEERING

$$L = 0.6\, T_C$$

$$L = \frac{\ell^{0.8}(S+1)^{1.67}}{9000\, Y^{0.5}}$$

$$S = \frac{1000}{CN} - 10$$

TAKE CN = 70 FOR WOODS

$$S = \frac{1000}{70} - 10 = 4.3$$

$$\ell = 2550 + 2750 = 5300 \text{ FT}$$

$$Y = \frac{0.14 + 0.073}{2} = 0.11 = 11\%$$

$$L = \frac{(5300)^{0.8}(4.3+1)^{1.67}}{9000(11)^{1/2}} = 0.52 \text{ hrs.}$$

$$T_C = \frac{0.52}{0.6} = 0.87 \text{ HRS} = \underline{\underline{52.2}} \text{ MIN}$$

SQUARES 1/4 IN. SCALE

3 – TEXAS HIGHWAY VELOCITY DATA

a) OVERLAND FLOW

$$SLOPE = 14\%$$

$$AVE.\ VELOCITY = 3.5\ FT/sec$$

$$T_C = \frac{2550\ FT}{3.5\ FT/sec} = 729\ sec = 12\ Min.$$

b) CHANNEL FLOW

$$SLOPE = 7.3\%$$

$$AVE.\ VELOCITY = 5\ FT/sec$$

$$T_C = \frac{2750\ FT}{5\ FT/sec} = 550\ sec = 9.2\ Min.$$

$$TOTAL\ T_C = 12 + 9.2 = \underline{21.2\ Min}$$

4 – KERBY METHOD

a) OVERLAND FLOW

$$T_C = 0.83\left(\frac{NL}{\sqrt{S}}\right)^{0.467}$$

$$L = 2750\ FT$$

$$N = 0.60$$

$$S = 0.073$$

$$T_C = 0.83\left[\frac{(0.6)(2750)}{\sqrt{0.14}}\right]^{0.467}$$

$$T_C = 42\ Min.$$

SQUARES 1/4 IN. SCALE

b) CHANNEL FLOW

$$V = \frac{1.49}{0.04}(0.83)^{2/3}(0.073) = 8.9 \text{ FT/SEC}$$

$$T_C = 5.1 \text{ min}$$

$$\text{TOTAL } T_C = 42 + 5.1 = \underline{\underline{47.1}} \text{ Min}$$

$$\text{AVE. } T_C = \frac{21.2 + 52.2 + 47.1 + 52.1}{4} = 44 \text{ Min}$$

$$\text{LAG TIME} = 0.6\,T_C = 0.6(44) = 26 \text{ Min}$$

$$\boxed{L = 26 \text{ Min}}$$

Anderson-Nichols & Company, Inc.

Subject KAMPE LAKE DAM

Sheet No. ____ of ____

Date 12-3-79

Computed MNM

Checked FUD

JOB NO. 3409-09

SQUARES 1/4 IN. SCALE

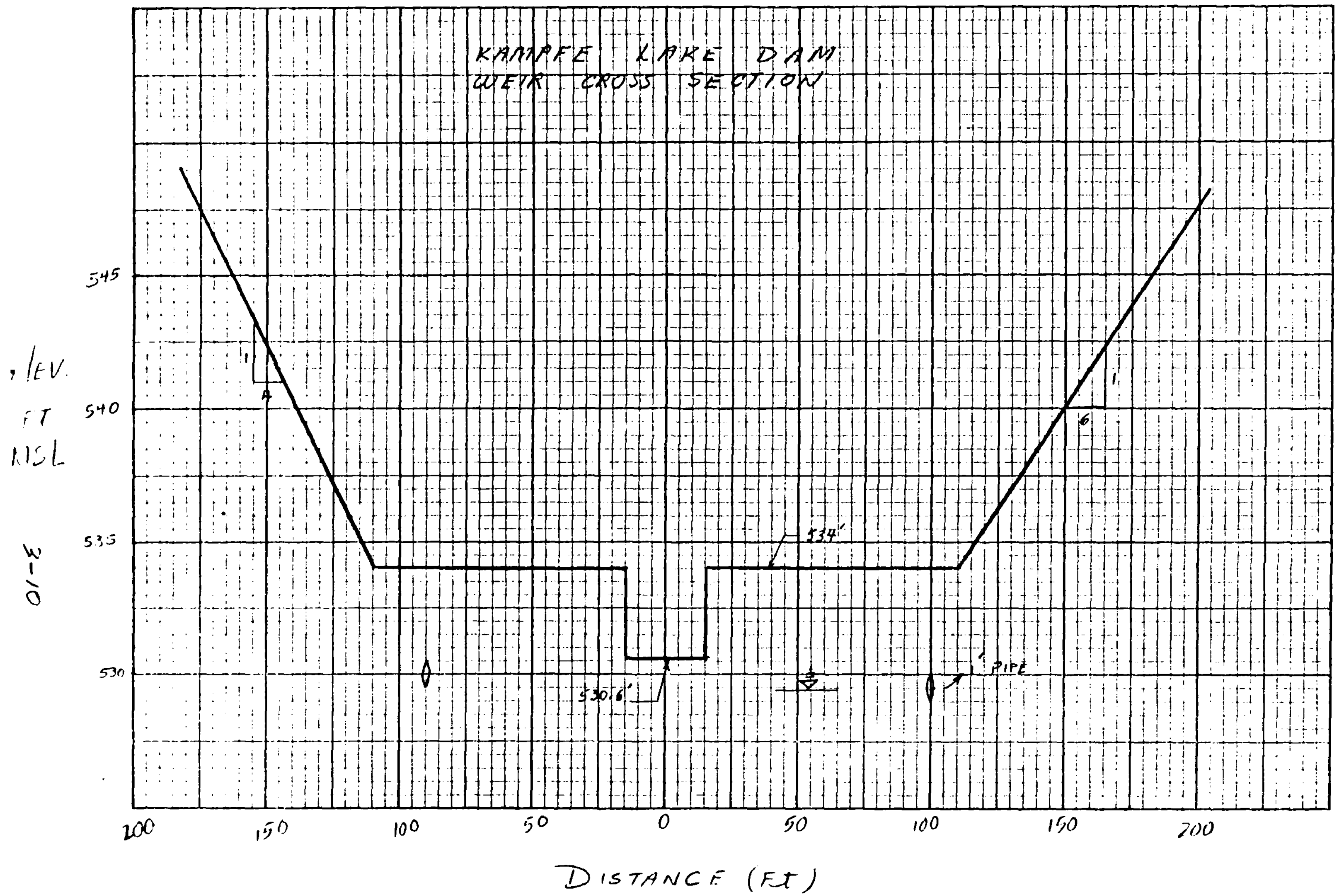
DEVELOPMENT OF RATING CURVE

USE THE WEIR EQUATION $Q = CLH^{3/2}$ TO DEVELOPE A RATING CURVE

*$C = 2.6$ FOR WOODED EMBANKMENT

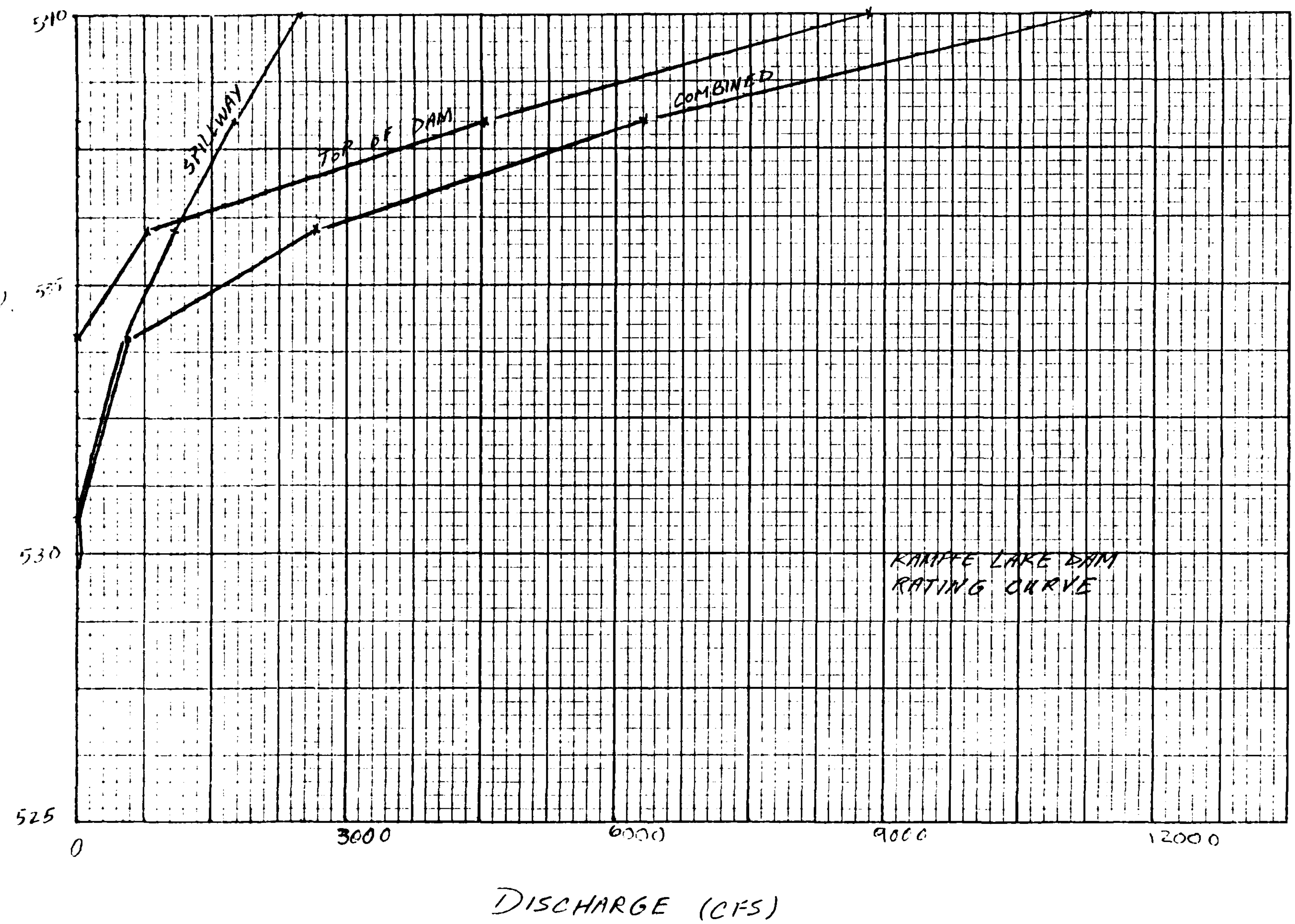
$C = 2.9$ FOR CONCRETE SECTION

* "C" VALUES WERE TAKEN FROM BRATER & KING "HANDBOOK OF HYDRAULICS" PAGE 5-40, TABLE 5-3


KAMPFE LAKE DAM
WEIR CROSS SECTION
ELEV. FT MSL
545
540
535
530
534'
530.6'
PIPE
1
4
1
6
200
150
100
50
0
50
100
150
200
DISTANCE (FT)

ELEVATION FT	SPILLWAY LENGTH = 30'		TOP OF DAM			TWO 1-FOOT DIAMETER PIPES * CFS	COMBINE Q CFS
	HEAD (FT)	Q (CFS)	HEAD (FT)	LENGTH (FT)	Q (CFS)		
529.5	0	0				0	0
530	0	0				1	1
530.6	0	0				6	6
534	3.4	545				18	563
536	5.4	1092	2	200	1530	18	2640
538	7.4	1751	4	210	4536	18	6305
540	9.4	2507	6	220	8730	18	11255

* DISCHARGE VALUES FOR 1-FOOT DIAMETER PIPES WERE TAKEN FROM "HYDRAULICS CHARTS FOR THE SELECTION OF HIGHWAY CULVERTS" U.S. DEPT. OF TRANSPORTATION, CIRCULAR NO. 5


KAMPFE LAKE DAM
RATING CURVE
SPILLWAY
TOP OF DAM
COMBINED
ELEV.
540
535
530
525
0
3000
6000
9000
12000
DISCHARGE (CFS)

Anderson-Nichols & Company, Inc.

Subject KAMPFE LAKE DAM

JOB NO. 3409-09

Sheet No. ____ of ____
Date 12-5-79
Computed MHM
Checked FDD

SQUARES 1/4 IN. SCALE

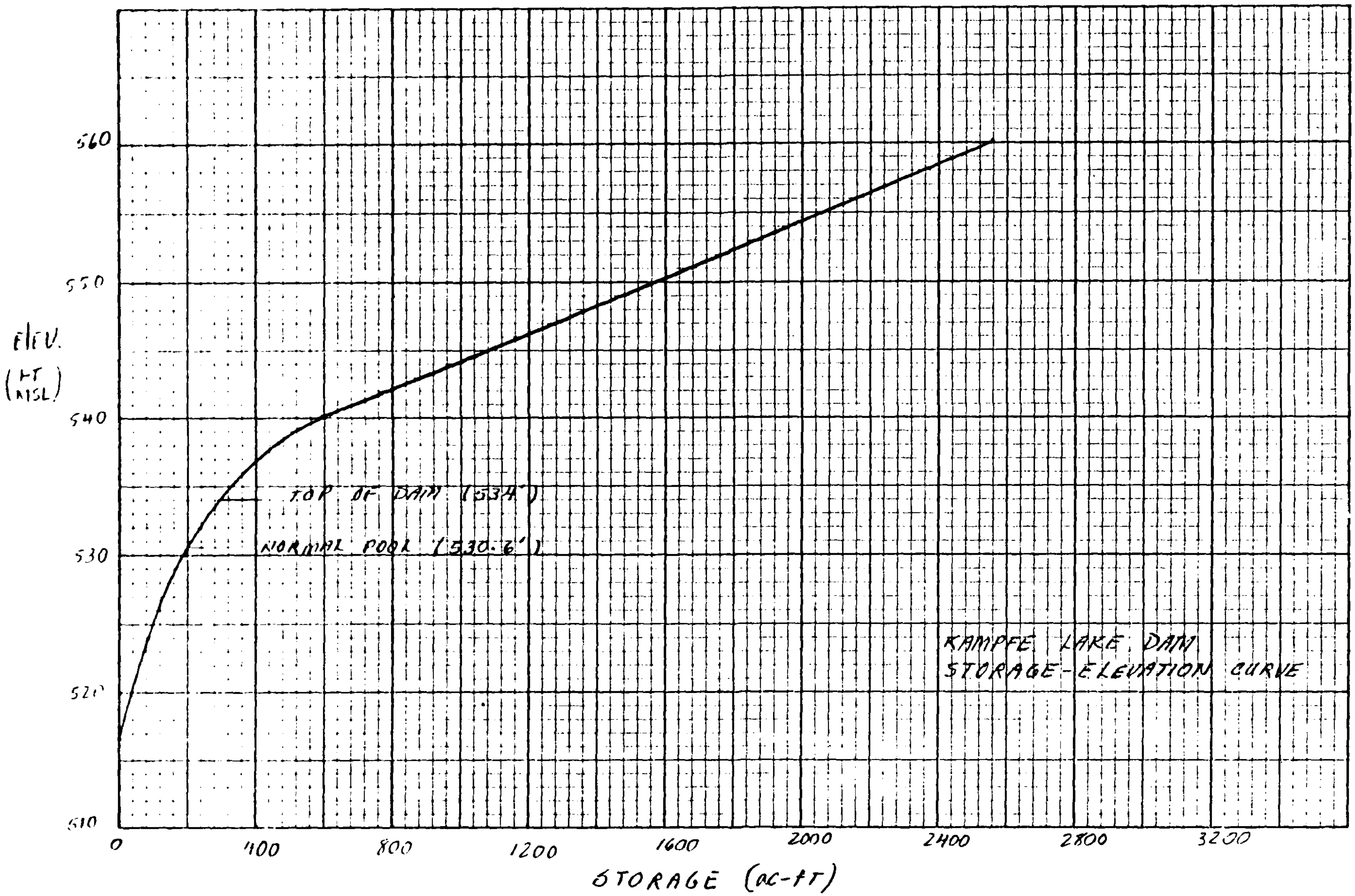
STORAGE - ELEVATION DETERMINATION

AVERAGE DEPTH = 6'

ELEVATION (FT)	SURFACE AREA (ac)	AVERAGE S.A. (ac)	INCREMENTAL STORAGE (ac-FT)	CUMULATIVE STORAGE (AC-FT)
		32	192	192
530	32			
		40.5	405	597
540	49			
		98	1960	2557
560	147			

HEC-1 INPUT

ELEV. (NGVD)	STORAGE (ac-FT)
516.6	0
529.5	188
530	192
530.6	210
534	300
536	370
538	450
540	597



560
550
540
530
520
510
ELEV.
(FT MSL)
0
400
800
1200
1600
2000
2400
2800
3200
STORAGE (ac-ft)
TOP OF DAM (534')
NORMAL POOL (530.6')
KAMPFE LAKE DAM
STORAGE-ELEVATION CURVE

SQUARES 1/4 IN SCALE

DETERMINE TIME OF CONCENTRATION

OVERLAND FLOW:

LENGTH = 2500 FT
HEAD = 880 - 530 = 350 FT

$$SLOPE = \frac{350}{2500} = 0.14$$

1- SCS TR #55 METHOD:

FROM FIG. 3-1. PAGE 3-2 USING FOREST WITH HEAVY GROUND LITTER & MEADOW

VELOCITY = 0.9 FT/SEC

$$T_c = \frac{2500\ FT}{0.9\ FT/SEC} = 2778\ SEC = \underline{46\ MIN}$$

2- SOIL & WATER CONSERVATION ENGINEERING METHOD:

$$L = 0.6\,T_c$$

$$L = \frac{\ell^{0.8}(S+1)^{1.67}}{9000\ Y^{0.5}}$$

$$S = \frac{1000}{CN} - 10$$

TAKE CN = 70 FOR WOODS

$$S = \frac{1000}{70} - 10 = 4.3$$

ℓ = 2500 FT
$Y = 0.14 = 14\%$

SQUARES 1/4 IN. SCALE

$$L = \frac{(2500)^{0.8} (4.3+1)^{1.67}}{9000 (14)^{0.5}} = 0.25 \text{ Hrs}$$

$$T_c = \frac{0.25}{0.6} = 0.42 \text{ Hrs} = 25 \text{ Min}$$

3 – TEXAS HIGHWAY VELOCITY DATA (DESIGN OF SMALL DAMS)

SLOPE = 14%

VELOCITY = 3.5 FT/SEC.

$$T_c = \frac{2500 \text{ FT}}{3.5 \text{ FT/Sec}} = 714 \text{ Sec} = 12 \text{ Min}$$

4 – KERBY METHOD:

$$T_c = 0.83 \left(\frac{NL}{\sqrt{S}}\right)^{0.467}$$

$L = 2500$ FT

$N = 0.60$

$S = 0.14$

$$T_c = 0.83 \left(\frac{(0.6)(2500)}{\sqrt{0.14}}\right)^{.467} = 40 \text{ MIN}$$

$$\text{AVERAGE } T_c = \frac{46+25+12+40}{4} = 31 \text{ Min}$$

L = LAG TIME $= 0.6\, T_c = 0.6\,(31)$

$$\boxed{L = 19 \text{ Min}}$$

SQUARES 1/4 IN. SCALE

D/S HAZARD:

STAR LAKE LOWER IS LOCATED JUST D/S OF STAR LAKE UPPER DAM. CAMPING AREA AND BUILDINGS ARE LOCATED D/S OF STAR LAKE LOWER DAM. ALL STRUCTURES ARE LOCATED BELOW THE WATER SURFACE ELEV. AT STAR LAKE LOWER. A BREACH ANALYSIS WAS CONDUCTED USING HEC-I COMPUTER PROGRAM TO DETERMINE THE EFFECT OF STAR LAKE UPPER DAM BREACH ON STAR LAKE LOWER DAM AND THE STRUCTURES LOCATED JUST D/S OF IT.

41°00'
74°22'30"

Mapped by the Army Map Service
Edited and published by the Geological Survey
Control by USGS, USC&GS, and New Jersey Geodetic Survey

B-16

SQUARES 1/4 IN. SCALE

DEVELOPMENT OF RATING CURVE

1 - SPILLWAY CURVE:

a) COMPUTE Q USING WEIR EQUATION ($Q = CLH^{3/2}$) UP TO LOW CHORD OF THE BRIDGE *C = 2.9

b) FROM 532.6' ELEV. USE ORIFICE FLOW FOR BRIDGE OPENING (*C = 0.82), AND WEIR FLOW OVER THE BRIDGE (*C = 2.3 IS USED TO ACCOUNT FOR LOSSES DUE TO THE BRIDGE)

2 - TOP OF DAM CURVE:

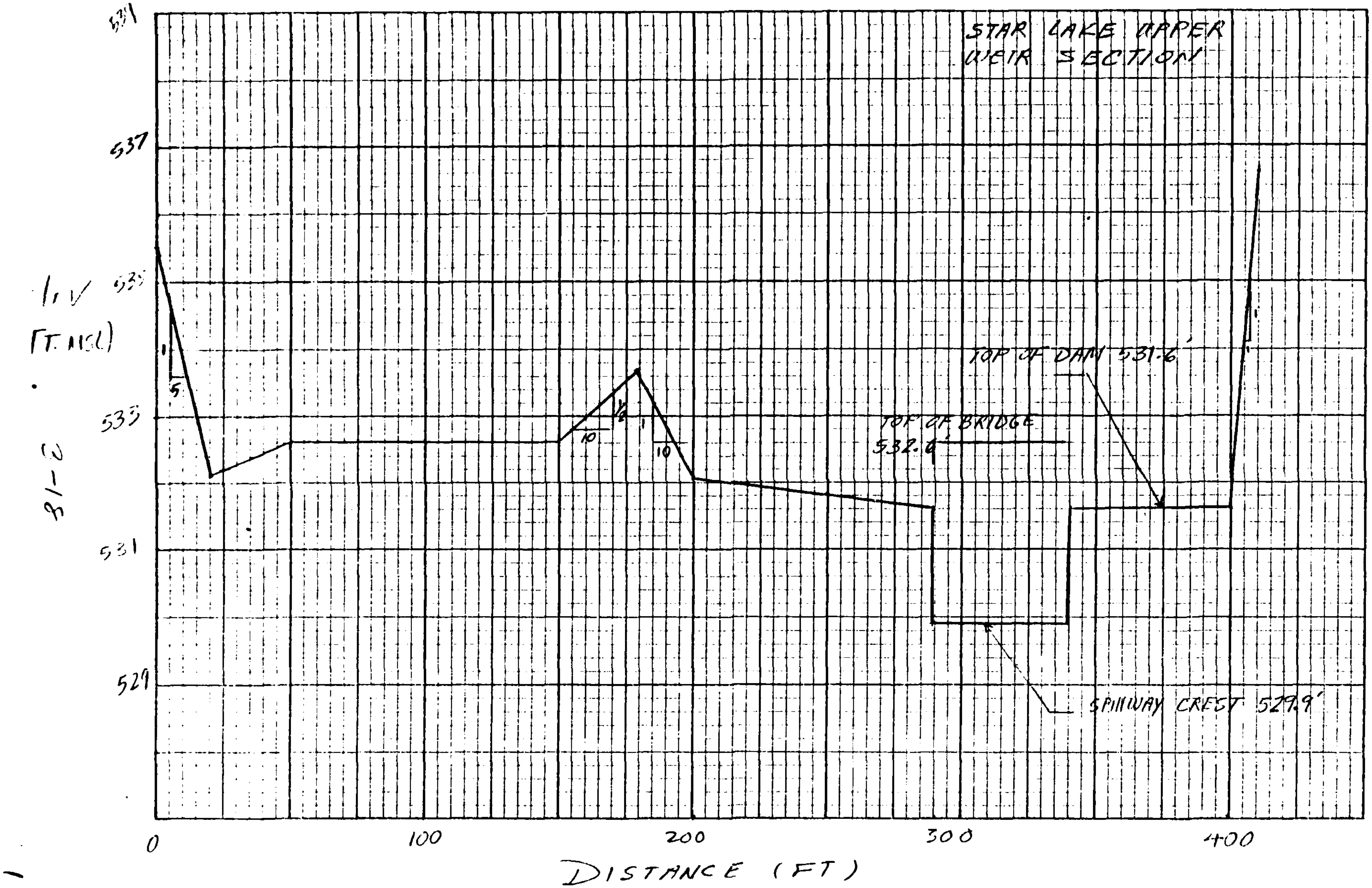
COMPUTE Q USING WEIR EQUATION $Q = CLH^{3/2}$ WHERE *C = 2.7

* "C" VALUES WERE TAKEN FROM BRATER & KING "HANDBOOK OF HYDRAULICS"

ELEV. (FT)	*SPILLWAY WEIR FLOW HEAD	WEIR FLOW Q	ORIFICE FLOW HEAD	ORIFICE FLOW Q	FLOW OVER BRIDGE HEAD	FLOW OVER BRIDGE Q	COMBINED Q	TOP OF DAM HEAD (FT)	TOP OF DAM LENGTH (FT)	TOP OF DAM Q (CFS)	COMBINED Q (CFS)
529.9	0	0	–	–	–	–	0				0
531	1.1	174	–	–	–	–	174				174
531.6	1.7	334	–	–	–	–	334				334
532.1	2.2	492	–	–	–	–	492	0.5	149	137	629
532.6	–	–	1.35	670	–	–	670	1.35	179	393	1430
533.7	–	–	2.45	980	1.1	138	1117	1.95	298	2128	3245
535	–	–	3.65	990	3.4	750	1740	3.25	358	5533	7360

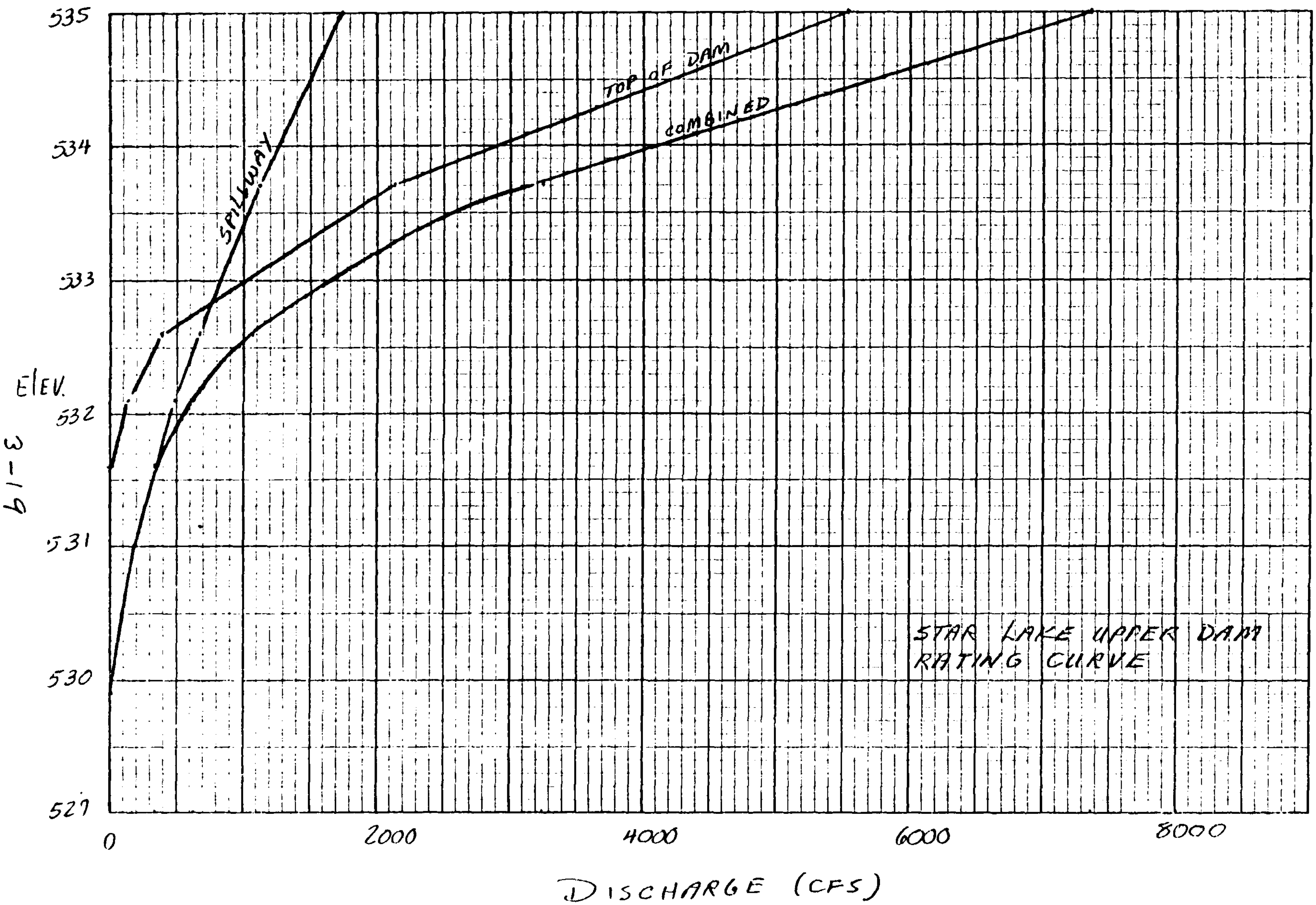
* LENGTH OF SPILLWAY = 52 FEET

SQUARES 1/4 IN. SCALE



COMPUTED: MNM
CKD : FDD

3-18


535
534
533
532
531
530
527
ElEV.
0
2000
4000
6000
8000
DISCHARGE (CFS)
SPILLWAY
TOP OF DAM
COMBINED
STAR LAKE UPPER DAM
RATING CURVE

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER DAM

JOB NO. 3409-09

Sheet No. ______ of ______
Date 12-7-79
Computed MJM
Checked FDD

SQUARES 1/4 IN. SCALE

STORAGE - ELEVATION DETERMINATION

MAXIMUM DEPTH = 8.3 FT

AVERAGE DEPTH = 7 FT

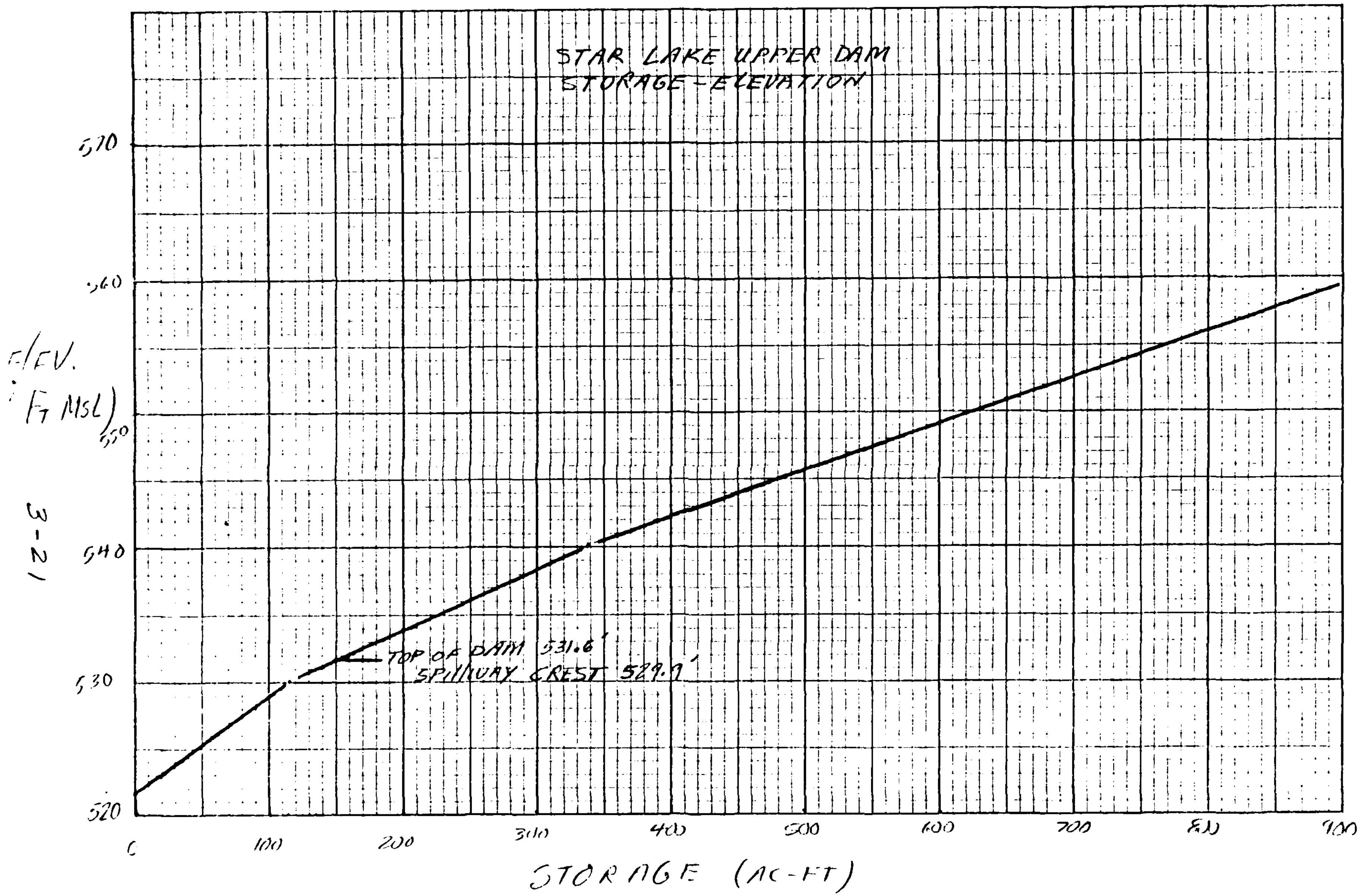
NORMAL POOL STORAGE = 115 AC-FT

ELEVATION FT MSL	SURFACE AREA (ACRES)	AVERAGE S. A. (AC.)	INCREMENTAL STORAGE AC-FT	CUMULATIVE STORAGE AC-FT
		16.5	115	115
530	16.5			
		22.2	222	337
540	28			
		29	580	917
560	30			

INPUT FOR HEC 1

ELEV. (FT MSL)	STORAGE (AC-FT)
521.5	0
529.9	115
531	136
531.6	150
532.1	165
532.6	172
533.7	197
535	225

COMPUTED: MNM
CKD: FDD



3-21

NO. 31,282. 10 DIVISIONS PER INCH BOTH WAYS. 90 BY 90 DIVISIONS.

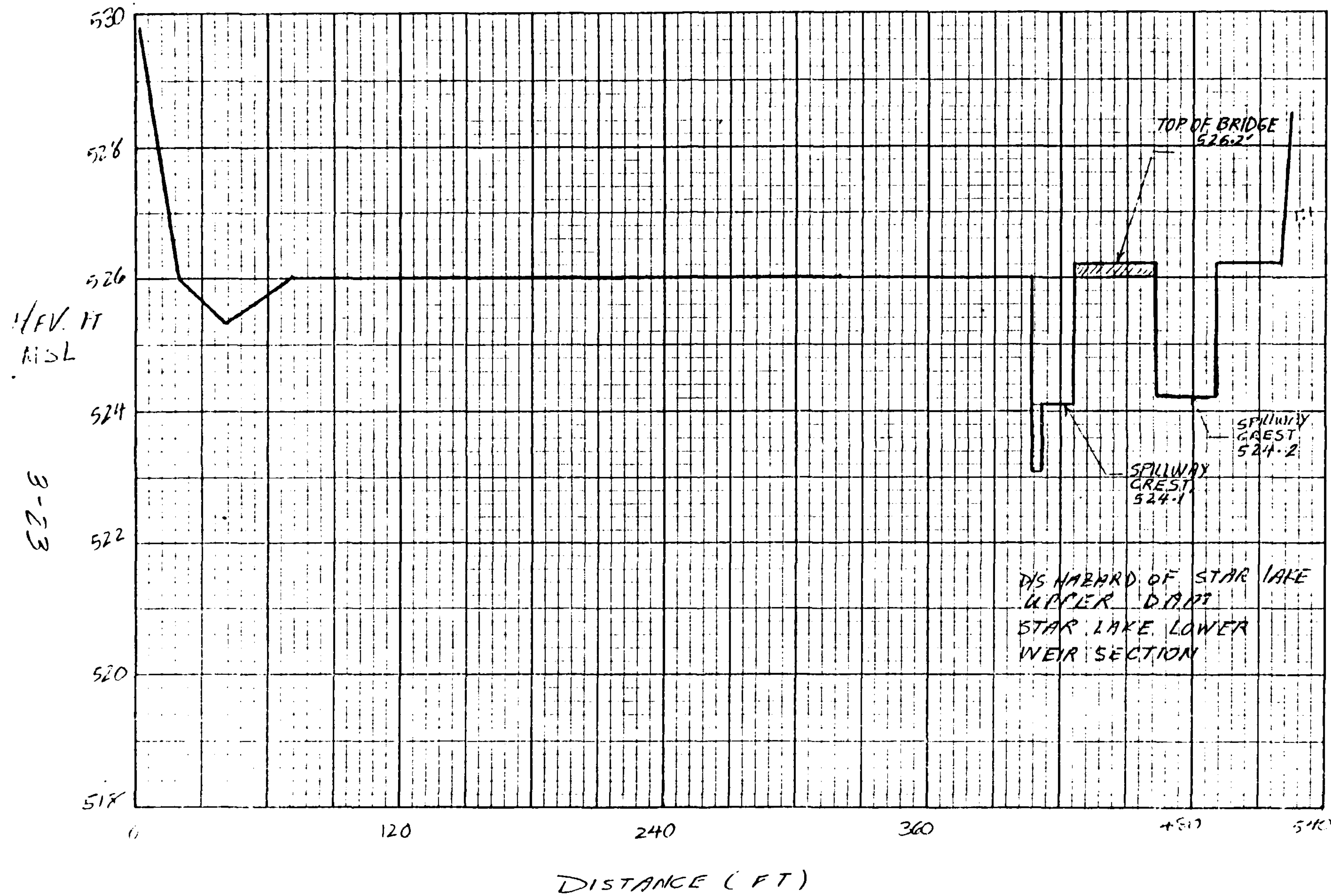
CODEX GRAPH PAPER IN STOCK DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. PRINTED IN U.S.A.

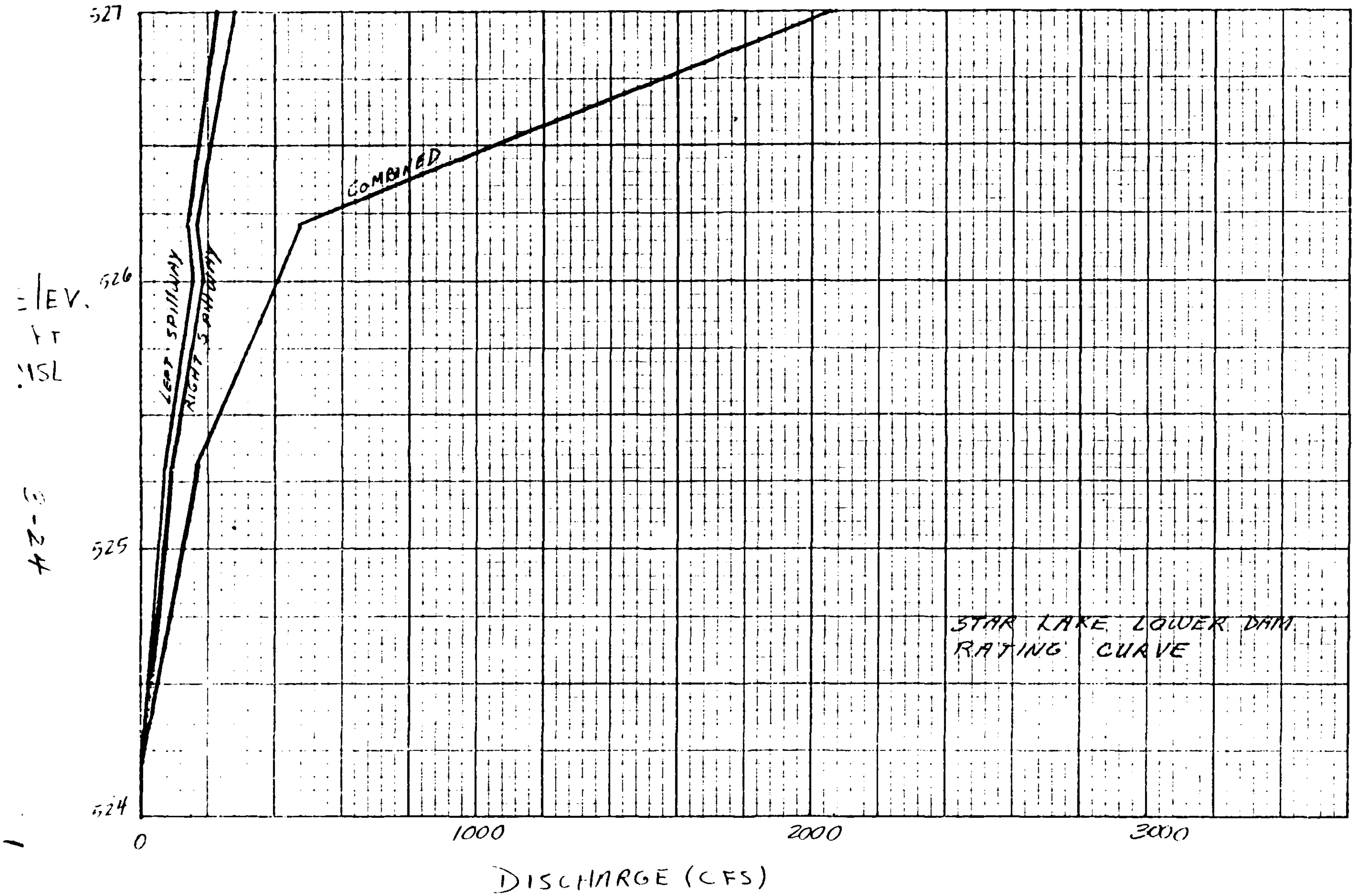
"RATING CURVE FOR STAR LAKE LOWER"

ELEV. (FT)	LEFT SPILLWAY L = 20 FT HEAD (FT)	LEFT SPILLWAY Q (CFS)	RIGHT SPILLWAY L = 26 FT HEAD (FT)	RIGHT SPILLWAY Q (CFS)	TOP OF DAM HEAD (FT)	TOP OF DAM LENGTH (FT)	TOP OF DAM Q (CFS)	COMBINED Q (CFS)
524.1	0	0	0	0				0
524.2	0.1	2	0	0				2
525.3	1.2	76	1.1	87	0		0	163
526	1.9	152	1.8	182	0.7	50	76	410
526.2	2.1	140	2	169	0.3	386	165	475
527	2.9	227	2.8	280	-	-	1562	2070

a) UP TO THE LOW CHORD OF THE BRIDGE USE WEIR EQUATION (*C = 2.9)
b) FROM LOW CHORD UP USE WEIR EQUATION WITH (C = 2.3) TO ACCOUNT FOR LOSSES DUE TO THE BRIDGE
c) C = 2.6 FOR DIRT ROAD

* "C" VALUES WERE TAKEN FROM BRATER & KING "HANDBOOK OF HYDRAULICS"


ELEV. FT MSL
530
528
526
524
522
520
518
0
120
240
360
480
540
DISTANCE (FT)
TOP OF BRIDGE 526.2'
SPILLWAY CREST 524.2
SPILLWAY CREST 524.1
D/S HAZARD OF STAR LAKE UPPER DAM
STAR LAKE LOWER WEIR SECTION



STAR LAKE LOWER DAM
RATING CURVE
COMBINED
LEFT SPILLWAY
RIGHT SPILLWAY
527
526
525
524
ELEV.
FT
MSL
0
1000
2000
3000
DISCHARGE (CFS)

E-24

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER

Sheet No. ____ of ____
Date 12-4-79
Computed MAM
Checked FDD

JOB NO. 3409-09

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

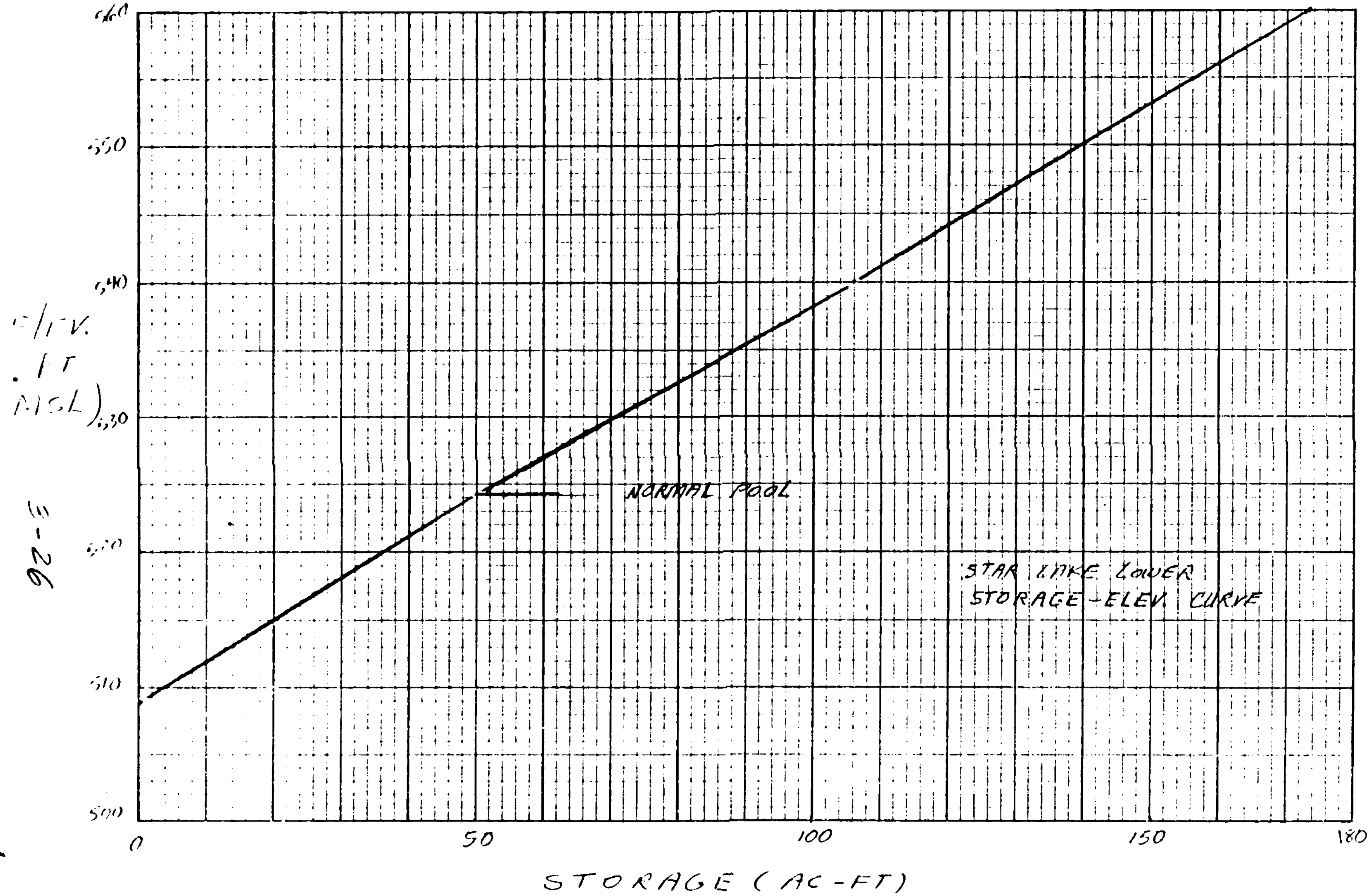
ELEV. - STORAGE DETERMINATION FOR STAR LAKE LOWER

MAXIMUM DEPTH OF LAKE = 17'
AVERAGE DEPTH OF LAKE = 9'

ELEV. FT MSL	SURFACE AREA (AC)	AVERAGE S. A. (AC)	INCREMENTAL STORAGE AC-FT	CUMULATIVE STORAGE AC-FT
		5.5	50	50
524.1	5.5			
		6.25	56	106
540	7			
		7.5	67.5	173.5
560	8			

INPUT FOR HEC 1

ELEV.	STORAGE
509 FT MSL	0 AC-FT
524.1	50
524.2	52
525.3	54
526	56
526.2	57
527	60



STAR LAKE LOWER
STORAGE-ELEV. CURVE
NORMAL POOL
ELEV. (FT MSL)
560
550
540
530
520
510
500
0
50
100
150
180
STORAGE (AC-FT)

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

D/S HAZARD ANALYSIS:

D/S HAZARD OF STAR LAKE UPPER DAM CONSISTS OF STAR LAKE LOWER DAM AND THREE STRUCTURES WHICH ARE LOCATED JUST D/S OF STAR LAKE LOWER DAM.

STAR LAKE LOWER DAM (TOP OF DAM)	525.3'
BAND STAND BUILDING	523.7'
BUILDING NO. 1	521.4'
BUILDING NO. 2	518.3'

IN CASE OF BREACH OF STAR LAKE UPPER DAM, STAR LAKE LOWER DAM COULD BE OVERTOPPED BY 1.6 FEET AND THE STRUCTURES COULD BE SEVERELY DAMAGED BY BREACH WAVE. POSSIBILITY OF LOSS OF LIFE EXISTS IF THE CAMPGROUND IS BEING USED.

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER DAM

JOB NO. 3409-09

Sheet No. ____ of ____
Date 12-6-79
Computed [illegible]
Checked TDD

DETERMINATION OF 'C' FOR LOW LEVEL OUTLETS

1- RIGHT LOW LEVEL OUTLET:

D = DIAMETER = 18" = 1.5'
N = 0.015 (SOIL & WATER CONSERVATION ENGINEERING) P. 632
A_P = AREA OF PIPE OPENNING = 1.8 FT^2
L_P = LENGTH OF PIPE = 25 FT
K_f = FRICTION LOSS THROUGH PIPE
K_e = " ENTRANCE LOSS OF PIPE = 0.78 (IBID P. 639)
C_P = COEFFICIENT OF DISCHARGE (INCORPORATING A_P & $2g$)
C = COEFFICIENT OF DISCHARGE

$$K_f = \frac{5087\, n^2}{D^{4/3}}$$

$$C_P = A_P \sqrt{\frac{2g}{1 + K_e + K_f L_P}}$$

$$C = \frac{C_P / A_P}{\sqrt{2g}}$$

$$K_f = \frac{5087\,(0.015)^2}{(18)^{4/3}} = 0.024$$

$$C_P = 1.8 \sqrt{\frac{64.4}{1 + 0.78 + (0.024)(25)}} = \underline{9.4}$$

$$C = \frac{9.4/1.8}{\sqrt{64.4}} = \underline{0.65}$$

2- LEFT LOW LEVEL OUTLET:

$D = 1.5'$
$L_P = 12'$

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER DAM

Sheet No. ______ of ______

Date 12-6-79

Computed ______

Checked ______

JOB NO. 3409-09

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

$$K_f = 0.024$$

$$C_p = 1.8 \sqrt{\frac{64.4}{1 + 0.78 + (.024)(12)}} = \underline{\underline{10}}$$

$$C = \frac{10/1.8}{\sqrt{64.4}} = \underline{\underline{0.69}}$$

Anderson-Nichols & Company, Inc.

Subject STAR LAKE UPPER DAM

JOB NO. 3409 - 09

Sheet No. ______ of ______
Date 12 - 6 - 79
Computed MHM
Checked FDD

SQUARES 1/4 IN SCALE

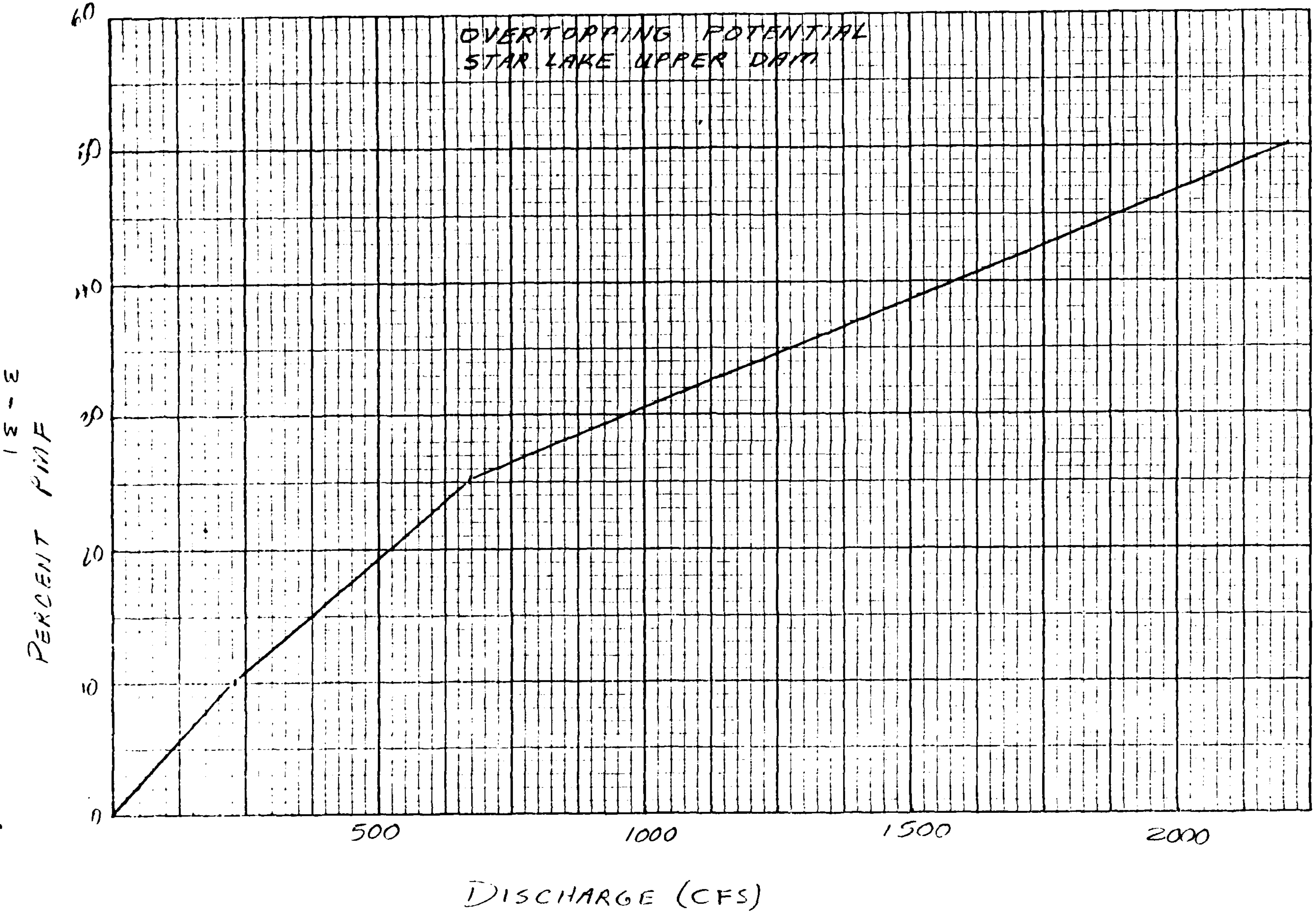
DRAWDOWN CALCULATIONS

CALCULATIONS ASSUME:

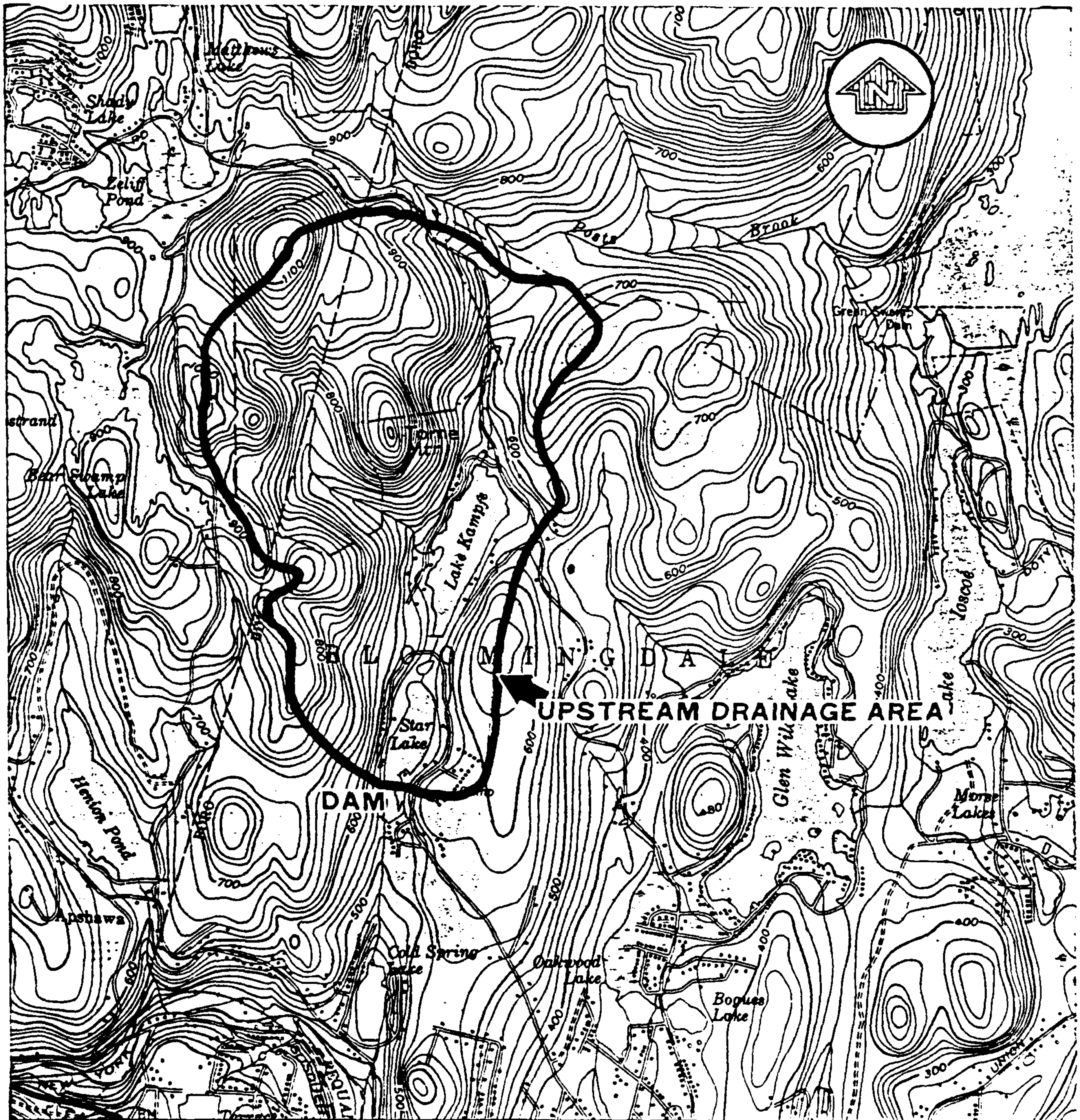
1 - NO SIGNIFICANT INFLOW
2 - LOW LEVEL OUTLETS TO BE OPERABLE
3 - INVERT U/S SAME AS INVERT AT GATE (526.5')
4 - $Q_P = C_P H^{1/2}$
5 - AC-FT-DAY = 1.9835 (AVG. Q)
6 - DAYS = Δ STORAGE / AC-FT-DAY
7 - Q_1 & Q_2 ARE RIGHT AND LEFT LOW-LEVEL OUTLETS DISCHARGE

ELEV. FT	STORAGE AC-FT	Δ STORAGE AC-FT	H FT	Q_1 CFS	Q_2 CFS	Q_{TOTAL} CFS	AVE. Q CFS	AC-FT PER DAY	DAY
529.9	115		3.4	17.3	18.4	35.7			
		20					31.5	62.5	.032
528.5	95		2	13.3	14	27.3			
		7					25.5	50.6	0.14
528	88		1.5	11.5	12.2	23.7			
		8					21.5	42.6	0.19
527.5	80		1.0	9.4	10	19.4			
		7					16.5	32.7	0.21
527	73		0.5	6.6	7.1	13.7			
		8					6.8	13.5	0.6
526.5	65		0	0	0	0			

1.5 DAYS



COMPUTED: MNM
CKD: FDD



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

STAR LAKE UPPER DAM

BOROUGH OF BLOOMINGDALE, NEW JERSEY

REGIONAL VICINITY MAP

JANUARY 1980

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

SCALE IN MILES

0 1/2 1

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEET. WANAQUE, N.J. 1954

HEC-1 OUTPUT

OVERTOPPING AND BREACH ANALYSIS

STAR LAKE UPPER DAM

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      ********************
      FLOOD HYDROGRAPH PACKAGE (HEC-1)
      DAM SAFETY VERSION      JULY 1978
      LAST MODIFICATION  26 FEB 79
      **************************
A1 STAR LAKE UPPER DAM OVERTOPPING ANALYSIS M.MIREMADI ANDERSON-NICHOLS
A2 DAM NUMBER NJ0022-52
A3 0.1 0.25 0.5 MULTIPLES OF 24 HOUR PMP
B     170       0      10       0       0       0       0       0       0       0
B1      5
J       2       3       1
J1    0.1    0.25     0.5
K       0      A1                                       1
K1 DEVELOP INFLOW HYDROGRAPH FOR KAMPFE LAKE
M       1       2    0.86                     0.8                               1
P              22     111     123     133
T                                                       1     0.1
W2           0.43
X      -3
K       1      A2                                       1
K1 ROUTE INFLOW HYDROGRAPH THROUGH KAMPFE LAKE RESERVOIR
Y                               1       1
Y1      1                                             210      -1
Y4  529.5     530   530.6     534     536     538     540
Y5      0       1       6     563    2640    6305   11255
$S      0     188     192     210     300     370     450     597
$E  516.6   529.5     530   530.6     534     536     538     540
$$  530.6
$D    534
K       0      A3                                       1
K1 DEVELOP INFLOW HYDROGRAPH FOR STAR LAKE
M       1       2    0.24                     0.8                               1
P              22     111     123     133
T                                                       1     0.1
W2           0.32
X      -3
K       2      A4                                       1
K1 COMBINE A2 AND A3 HYDROGRAPHS
K       1      A5                                       1
K1 ROUTE INFLOW HYDROGRAPH THROUGH STAR LAKE RESERVOIR
Y                               1       1
Y1      1                                             115      -1
Y4  529.9     531   531.6   532.1   532.6   533.7     535
Y5      0     174     334     629    1413    3245    7360
$S      0     115     136     150     165     172     197     225
$E  521.6   529.9     531   531.6   532.1   532.6   533.7     535
$$  529.9
$D  531.6
$B     10       1   521.6       1   529.9   531.6
$B     10       1   521.6       1   529.9     550
K       1      A6                                       1
K1 ROUTE BREACH OUTFLOW HYDROGRAPH THROUGH STAR LAKE LOWER RESERVOIR
Y                               1       1
Y1      1                                              50      -1
Y4  524.1   524.2   525.3     526   526.2     527
```

```
 51          Y5      0      2     163     410     475    2070
 52          $S      0     50      52      54      56      57      60
 53          $E    509  524.1   524.2   525.3     526   526.2     527
 54          $$ 524.1
 55          $D 525.3
 56          K      99
```

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PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

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RUNOFF HYDROGRAPH AT          A1
ROUTE HYDROGRAPH TO           A2
RUNOFF HYDROGRAPH AT          A3
COMBINE  2 HYDROGRAPHS AT     A4
ROUTE HYDROGRAPH TO           A5
ROUTE HYDROGRAPH TO           A6
END OF NETWORK
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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE* 79/12/06.
     TIME* 07.39.29.


              STAR LAKE UPPER DAM OVERTOPPING ANALYSIS M.MIREHADI ANDERSON-NICHOLS
              DAM NUMBER NJ0022-52
              0.1 0.25 0.5 MULTIPLES OF 24 HOUR PMP

                                 JOB SPECIFICATION
              NO      NHR     NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
             170        0       10       0       0       0       0       0       0       0
                                      JOPER     NWT   LROPT   TRACE
                                          5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 2 NPTIO= 3 LRTIO= 1
               RTIOS=    .10    .25    .50

***********          ***********          ***********          ***********          ***********

                               SUB-AREA RUNOFF COMPUTATION

            DEVELOP INFLOW HYDROGRAPH FOR KAMPFE LAKE

                        ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                           A1       0       0       0       0       0       1       0       0

                                      HYDROGRAPH DATA
             IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                 1      2     .86    0.00     .86     .80   0.000       0       1       0

                                        PRECIP DATA
                     SPFE     PMS      R6     R12     R24     R48     R72     R96
                     0.00   22.00  111.00  123.00  133.00    0.00    0.00    0.00

                                         LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .10    0.00    0.00

                                   UNIT HYDROGRAPH DATA
                                 TC=  0.00      LAG=   .43

                                      RECESSION DATA
                           STRTQ=   -3.00    QRCSN=    0.00    RTIOR= 1.00

            UNIT HYDROGRAPH 15 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=    .43  VOL= 1.00
          178.      599.      802.      698.      435.      248.      150.       87.       52.       30.
           18.       11.        7.        4.        1.

0                                  END-OF-PERIOD FLOW
```

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.02	0.00	.02	3.	1.01	14.20	86	.49	.47	.02	1315.
1.01	.20	2	.02	0.00	.02	3.	1.01	14.30	87	.49	.47	.02	1398.
1.01	.30	3	.02	0.00	.02	3.	1.01	14.40	88	.49	.47	.02	1468.
1.01	.40	4	.02	0.00	.02	3.	1.01	14.50	89	.49	.47	.02	1512.
1.01	.50	5	.02	0.00	.02	3.	1.01	15.00	90	.49	.47	.02	1537.
1.01	1.00	6	.02	0.00	.02	3.	1.01	15.10	91	.45	.43	.02	1544.
1.01	1.10	7	.02	0.00	.02	3.	1.01	15.20	92	.74	.73	.02	1580.
1.01	1.20	8	.02	0.00	.02	3.	1.01	15.30	93	1.34	1.32	.02	1834.
1.01	1.30	9	.02	0.00	.02	3.	1.01	15.40	94	3.34	3.32	.02	2761.
1.01	1.40	10	.02	0.00	.02	3.	1.01	15.50	95	.97	.95	.02	4210.
1.01	1.50	11	.02	0.00	.02	3.	1.01	16.00	96	.59	.58	.02	4876.
1.01	2.00	12	.02	0.00	.02	3.	1.01	16.10	97	.46	.44	.02	4433.
1.01	2.10	13	.02	0.00	.02	3.	1.01	16.20	98	.46	.44	.02	3452.
1.01	2.20	14	.02	0.00	.02	3.	1.01	16.30	99	.46	.44	.02	2657.
1.01	2.30	15	.02	0.00	.02	3.	1.01	16.40	100	.46	.44	.02	2177.
1.01	2.40	16	.02	0.00	.02	3.	1.01	16.50	101	.46	.44	.02	1881.
1.01	2.50	17	.02	0.00	.02	3.	1.01	17.00	102	.46	.44	.02	1710.
1.01	3.00	18	.02	0.00	.02	3.	1.01	17.10	103	.36	.34	.02	1592.
1.01	3.10	19	.02	0.00	.02	3.	1.01	17.20	104	.36	.34	.02	1474.
1.01	3.20	20	.02	0.00	.02	3.	1.01	17.30	105	.36	.34	.02	1360.
1.01	3.30	21	.02	0.00	.02	3.	1.01	17.40	106	.36	.34	.02	1272.
1.01	3.40	22	.02	0.00	.02	3.	1.01	17.50	107	.36	.34	.02	1215.
1.01	3.50	23	.02	0.00	.02	3.	1.01	18.00	108	.36	.34	.02	1180.
1.01	4.00	24	.02	0.00	.02	3.	1.01	18.10	109	.03	.01	.02	1102.
1.01	4.10	25	.02	0.00	.02	3.	1.01	18.20	110	.03	.01	.02	895.
1.01	4.20	26	.02	0.00	.02	3.	1.01	18.30	111	.03	.01	.02	624.
1.01	4.30	27	.02	0.00	.02	3.	1.01	18.40	112	.03	.01	.02	392.
1.01	4.40	28	.02	0.00	.02	3.	1.01	18.50	113	.03	.01	.02	247.
1.01	4.50	29	.02	0.00	.02	3.	1.01	19.00	114	.03	.01	.02	164.
1.01	5.00	30	.02	0.00	.02	3.	1.01	19.10	115	.03	.01	.02	114.
1.01	5.10	31	.02	0.00	.02	3.	1.01	19.20	116	.03	.01	.02	85.
1.01	5.20	32	.02	0.00	.02	3.	1.01	19.30	117	.03	.01	.02	68.
1.01	5.30	33	.02	0.00	.02	3.	1.01	19.40	118	.03	.01	.02	58.
1.01	5.40	34	.02	0.00	.02	3.	1.01	19.50	119	.03	.01	.02	52.
1.01	5.50	35	.02	0.00	.02	3.	1.01	20.00	120	.03	.01	.02	49.
1.01	6.00	36	.02	0.00	.02	3.	1.01	20.10	121	.03	.01	.02	46.
1.01	6.10	37	.06	0.00	.06	3.	1.01	20.20	122	.03	.01	.02	45.
1.01	6.20	38	.06	0.00	.06	3.	1.01	20.30	123	.03	.01	.02	45.
1.01	6.30	39	.06	0.00	.06	3.	1.01	20.40	124	.03	.01	.02	45.
1.01	6.40	40	.06	0.00	.06	3.	1.01	20.50	125	.03	.01	.02	45.
1.01	6.50	41	.06	0.00	.06	3.	1.01	21.00	126	.03	.01	.02	45.
1.01	7.00	42	.06	.04	.02	10.	1.01	21.10	127	.03	.01	.02	45.
1.01	7.10	43	.06	.04	.02	34.	1.01	21.20	128	.03	.01	.02	45.
1.01	7.20	44	.06	.04	.02	68.	1.01	21.30	129	.03	.01	.02	45.
1.01	7.30	45	.06	.04	.02	97.	1.01	21.40	130	.03	.01	.02	45.
1.01	7.40	46	.06	.04	.02	116.	1.01	21.50	131	.03	.01	.02	45.
1.01	7.50	47	.06	.04	.02	127.	1.01	22.00	132	.03	.01	.02	45.
1.01	8.00	48	.06	.04	.02	133.	1.01	22.10	133	.03	.01	.02	45.
1.01	8.10	49	.06	.04	.02	137.	1.01	22.20	134	.03	.01	.02	45.
1.01	8.20	50	.06	.04	.02	139.	1.01	22.30	135	.03	.01	.02	45.
1.01	8.30	51	.06	.04	.02	141.	1.01	22.40	136	.03	.01	.02	45.
1.01	8.40	52	.06	.04	.02	141.	1.01	22.50	137	.03	.01	.02	45.
1.01	8.50	53	.06	.04	.02	142.	1.01	23.00	138	.03	.01	.02	45.
1.01	9.00	54	.06	.04	.02	142.	1.01	23.10	139	.03	.01	.02	45.
1.01	9.10	55	.06	.04	.02	142.	1.01	23.20	140	.03	.01	.02	45.
1.01	9.20	56	.06	.04	.02	142.	1.01	23.30	141	.03	.01	.02	45.
1.01	9.30	57	.06	.04	.02	142.	1.01	23.40	142	.03	.01	.02	45.
1.01	9.40	58	.06	.04	.02	142.	1.01	23.50	143	.03	.01	.02	45.

1.01	9.50	59	.06	.04	.02	142.	1.02	0.00	144	.03	.01	.02		45.
1.01	10.00	60	.06	.04	.02	142.	1.02	.10	145	0.00	0.00	0.00		42.
1.01	10.10	61	.06	.04	.02	142.	1.02	.20	146	0.00	0.00	0.00		35.
1.01	10.20	62	.06	.04	.02	142.	1.02	.30	147	0.00	0.00	0.00		25.
1.01	10.30	63	.06	.04	.02	142.	1.02	.40	148	0.00	0.00	0.00		16.
1.01	10.40	64	.06	.04	.02	142.	1.02	.50	149	0.00	0.00	0.00		10.
1.01	10.50	65	.06	.04	.02	142.	1.02	1.00	150	0.00	0.00	0.00		7.
1.01	11.00	66	.06	.04	.02	142.	1.02	1.10	151	0.00	0.00	0.00		5.
1.01	11.10	67	.06	.04	.02	142.	1.02	1.20	152	0.00	0.00	0.00		4.
1.01	11.20	68	.06	.04	.02	142.	1.02	1.30	153	0.00	0.00	0.00		3.
1.01	11.30	69	.06	.04	.02	142.	1.02	1.40	154	0.00	0.00	0.00		3.
1.01	11.40	70	.06	.04	.02	142.	1.02	1.50	155	0.00	0.00	0.00		3.
1.01	11.50	71	.06	.04	.02	142.	1.02	2.00	156	0.00	0.00	0.00		3.
1.01	12.00	72	.06	.04	.02	142.	1.02	2.10	157	0.00	0.00	0.00		3.
1.01	12.10	73	.33	.31	.02	190.	1.02	2.20	158	0.00	0.00	0.00		3.
1.01	12.20	74	.33	.31	.02	350.	1.02	2.30	159	0.00	0.00	0.00		3.
1.01	12.30	75	.33	.31	.02	566.	1.02	2.40	160	0.00	0.00	0.00		3.
1.01	12.40	76	.33	.31	.02	752.	1.02	2.50	161	0.00	0.00	0.00		3.
1.01	12.50	77	.33	.31	.02	869.	1.02	3.00	162	0.00	0.00	0.00		3.
1.01	13.00	78	.33	.31	.02	935.	1.02	3.10	163	0.00	0.00	0.00		3.
1.01	13.10	79	.39	.37	.02	987.	1.02	3.20	164	0.00	0.00	0.00		3.
1.01	13.20	80	.39	.37	.02	1049.	1.02	3.30	165	0.00	0.00	0.00		3.
1.01	13.30	81	.39	.37	.02	1115.	1.02	3.40	166	0.00	0.00	0.00		3.
1.01	13.40	82	.39	.37	.02	1169.	1.02	3.50	167	0.00	0.00	0.00		3.
1.01	13.50	83	.39	.37	.02	1202.	1.02	4.00	168	0.00	0.00	0.00		3.
1.01	14.00	84	.39	.37	.02	1221.	1.02	4.10	169	0.00	0.00	0.00		3.
1.01	14.10	85	.49	.47	.02	1250.	1.02	4.20	170	0.00	0.00	0.00		3.
									SUM	23.41	20.69	2.72		69328.
										(595.)	(526.)	(69.)		(1963.15)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4876.	1711.	481.	408.	69303.
CMS	138.	48.	14.	12.	1962.
INCHES		18.50	20.80	20.82	20.82
MM		469.96	528.41	528.91	528.91
AC-FT		848.	954.	955.	955.
THOUS CU M		1046.	1176.	1177.	1177.

HYDROGRAPH AT STA A1 FOR PLAN 1, RTIO 3

1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	5.	17.	34.	49.	58.	63.	67.	69.	70.
70.	71.	71.	71.	71.	71.	71.	71.	71.	71.
71.	71.	71.	71.	71.	71.	71.	71.	71.	71.
71.	71.	95.	175.	283.	376.	434.	467.	493.	524.
558.	584.	601.	611.	625.	658.	699.	734.	756.	768.
772.	790.	917.	1380.	2105.	2438.	2216.	1726.	1329.	1088.
941.	855.	796.	737.	680.	636.	607.	590.	551.	448.
312.	194.	123.	82.	57.	42.	34.	29.	26.	24.
23.	23.	22.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	21.	17.	12.	8.	5.	4.
3.	2.	2.	2.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2438.	855.	240.	204.	34652.

```
                     CMS       69.        24.        7.         6.          981.
                  INCHES                 9.25     10.40      10.41         10.41
                      MM               234.98    264.21     264.45        264.45
                   AC-FT                 424.      477.       477.          477.
              THOUS CU M                 523.      588.       589.          589.

PLAN 2 SAME AS PLAN 1

      **********          **********          **********          **********          **********

                                        HYDROGRAPH ROUTING

             ROUTE INFLOW HYDROGRAPH THROUGH KAMPFE LAKE RESERVOIR

                            ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                               A2       1       0       0       0       0       1       0       0

                                       ALL PLANS HAVE SAME
                                          ROUTING DATA
                    QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                      0.0   0.000    0.00       1       1       0       0               0

                            NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                1       0       0   0.000   0.000   0.000    210.      -1

  STAGE       529.50     530.00     530.60     534.00     536.00     538.00     540.00

   FLOW         0.00       1.00       6.00     563.00    2640.00    6305.00   11255.00

    CAPACITY=        0.       188.       192.       210.       300.       370.       450.       597.

   ELEVATION=      517.       530.       530.       531.       534.       536.       538.       540.

                            CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                           530.6     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                               DAM DATA
                                      TOPEL    COQD    EXPD   DAMWID
                                      534.0     0.0     0.0       0.
```

STATION A2, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	6.	6.	6.	9.	14.	19.
23.	27.	30.	34.	37.	40.	42.	45.	47.	49.
51.	52.	54.	55.	57.	58.	59.	60.	61.	62.
62.	63.	65.	70.	83.	104.	128.	155.	181.	208.
235.	263.	290.	316.	340.	365.	390.	417.	444.	470.
495.	518.	545.	695.	1050.	1465.	1757.	1830.	1727.	1551.
1369.	1209.	1079.	973.	883.	807.	744.	695.	653.	601.
554.	529.	499.	467.	434.	403.	373.	345.	319.	295.
273.	252.	234.	216.	201.	186.	173.	160.	149.	139.
129.	120.	112.	105.	98.	92.	86.	81.	76.	72.
68.	64.	61.	58.	55.	52.	49.	46.	42.	39.
36.	34.	31.	29.	26.	24.	22.	21.	19.	18.
16.	15.	14.	13.	12.	11.	10.	10.	9.	8.

STORAGE

210.	210.	210.	210.	210.	210.	210.	209.	209.	209.
209.	209.	209.	209.	209.	209.	209.	209.	209.	209.
209.	209.	209.	209.	208.	208.	208.	208.	208.	208.
208.	208.	208.	208.	208.	208.	208.	208.	208.	208.
208.	208.	208.	208.	208.	209.	210.	211.	211.	212.
213.	213.	214.	214.	215.	215.	216.	216.	217.	217.
217.	217.	218.	218.	218.	218.	219.	219.	219.	219.
219.	219.	219.	220.	223.	226.	230.	234.	238.	243.
247.	251.	256.	260.	264.	268.	272.	276.	281.	285.
289.	293.	297.	304.	316.	330.	340.	343.	339.	333.
327.	322.	317.	314.	311.	308.	306.	304.	303.	301.
299.	295.	290.	284.	279.	274.	269.	265.	261.	257.
253.	250.	247.	244.	241.	239.	237.	235.	233.	231.
230.	228.	227.	226.	225.	224.	223.	222.	221.	221.
220.	219.	219.	218.	218.	217.	217.	216.	216.	215.
215.	214.	214.	214.	213.	213.	213.	212.	212.	212.
212.	211.	211.	211.	211.	211.	211.	211.	210.	210.

STAGE

530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6
530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6
530.6	530.6	530.6	530.6	530.5	530.5	530.5	530.5	530.5	530.5
530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5
530.5	530.5	530.5	530.5	530.5	530.6	530.6	530.6	530.7	530.7
530.7	530.7	530.7	530.8	530.8	530.8	530.8	530.8	530.8	530.9

530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9
530.9	530.9	531.0	531.0	531.1	531.2	531.3	531.5	531.7	531.8
532.0	532.2	532.3	532.5	532.6	532.8	532.9	533.1	533.3	533.4
533.5	533.7	533.9	534.1	534.5	534.9	535.2	535.2	535.1	535.0
534.8	534.6	534.5	534.4	534.3	534.2	534.2	534.1	534.1	534.0
533.9	533.8	533.6	533.4	533.2	533.0	532.8	532.7	532.5	532.4
532.2	532.1	532.0	531.9	531.8	531.7	531.6	531.5	531.5	531.4
531.4	531.3	531.2	531.2	531.2	531.1	531.1	531.1	531.0	531.0
531.0	531.0	530.9	530.9	530.9	530.9	530.9	530.8	530.8	530.8
530.8	530.8	530.8	530.7	530.7	530.7	530.7	530.7	530.7	530.7
530.7	530.7	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6

PEAK OUTFLOW IS 1830. AT TIME 16.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1830.	758.	239.	204.	34621.
CMS	52.	21.	7.	6.	980.
INCHES		8.20	10.36	10.40	10.40
MM		208.36	263.12	264.22	264.22
AC-FT		376.	475.	477.	477.
THOUS CU M		464.	586.	588.	588.

STATION A2, PLAN 2, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.

6.	6.	6.	6.	6.	6.	6.	6.	6.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	6.	6.	6.	9.	14.	19.
23.	27.	30.	34.	37.	40.	42.	45.	47.	49.
51.	52.	54.	55.	57.	58.	59.	60.	61.	62.
62.	63.	65.	70.	83.	104.	128.	155.	181.	208.
235.	263.	290.	316.	340.	365.	390.	417.	444.	470.
495.	518.	545.	695.	1050.	1465.	1757.	1830.	1727.	1551.
1369.	1209.	1079.	973.	883.	807.	744.	695.	653.	601.
554.	529.	499.	467.	434.	403.	373.	345.	315.	295.
273.	252.	234.	216.	201.	186.	173.	160.	149.	139.
129.	120.	112.	105.	98.	92.	86.	81.	76.	72.
68.	64.	61.	58.	55.	52.	49.	46.	42.	39.
36.	34.	31.	29.	26.	24.	22.	21.	19.	18.
16.	15.	14.	13.	12.	11.	10.	10.	9.	8.

STORAGE

210.	210.	210.	210.	210.	210.	210.	209.	209.	209.
209.	209.	209.	209.	209.	209.	209.	209.	209.	209.
209.	209.	209.	209.	208.	208.	208.	208.	208.	208.
208.	208.	208.	208.	208.	208.	208.	208.	208.	208.
208.	208.	208.	208.	208.	209.	210.	211.	211.	212.
213.	213.	214.	214.	215.	215.	216.	216.	217.	217.
217.	217.	218.	218.	218.	218.	219.	219.	219.	219.
219.	219.	219.	220.	223.	226.	230.	234.	238.	243.
247.	251.	256.	260.	264.	268.	272.	276.	281.	285.
289.	293.	297.	304.	316.	330.	340.	343.	339.	333.
327.	322.	317.	314.	311.	308.	306.	304.	303.	301.
299.	295.	290.	284.	279.	274.	269.	265.	261.	257.
253.	250.	247.	244.	241.	239.	237.	235.	233.	231.
230.	228.	227.	226.	225.	224.	223.	222.	221.	221.
220.	219.	219.	218.	218.	217.	217.	216.	216.	215.
215.	214.	214.	214.	213.	213.	213.	212.	212.	212.
212.	211.	211.	211.	211.	211.	211.	211.	210.	210.

STAGE

530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6
530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6
530.6	530.6	530.6	530.6	530.5	530.5	530.5	530.5	530.5	530.5
530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5	530.5
530.5	530.5	530.5	530.5	530.5	530.6	530.6	530.6	530.7	530.7
530.7	530.7	530.7	530.8	530.8	530.8	530.8	530.8	530.8	530.9
530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.9
530.9	530.9	531.0	531.0	531.1	531.2	531.3	531.5	531.7	531.8
532.0	532.2	532.3	532.5	532.6	532.8	532.9	533.1	533.3	533.4
533.6	533.7	533.9	534.1	534.5	534.9	535.2	535.2	535.1	535.0
534.8	534.6	534.5	534.4	534.3	534.2	534.2	534.1	534.1	534.0
533.9	533.8	533.6	533.4	533.2	533.0	532.8	532.7	532.5	532.4
532.2	532.1	532.0	531.9	531.8	531.7	531.6	531.5	531.5	531.4
531.4	531.3	531.2	531.2	531.2	531.1	531.1	531.1	531.0	531.0
531.0	531.0	530.9	530.9	530.9	530.9	530.9	530.8	530.8	530.8
530.8	530.8	530.8	530.7	530.7	530.7	530.7	530.7	530.7	530.7
530.7	530.7	530.6	530.6	530.6	530.6	530.6	530.6	530.6	530.6

PEAK OUTFLOW IS 1830. AT TIME 16.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1830.	758.	275.	204.	34621.
CMS	52.	21.	7.	6.	980.

INCHES	8.20	10.36	10.40	10.40
MM	208.36	263.12	264.22	264.22
AC-FT	376.	475.	477.	477.
THOUS CU M	464.	586.	588.	588.

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

DEVELOP INFLOW HYDROGRAPH FOR STAR LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
43	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.24	0.00	.24	.80	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	111.00	123.00	133.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .32

RECESSION DATA

STRTQ= -3.00 QRCSN= 0.00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .32 VOL= 1.00

96.	274.	261.	147.	74.	38.	19.	10.	5.	3.
1.	0.								

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.02	0.00	.02	1.	1.01	14.20	86	.49	.47	.02	384.
1.01	.20	2	.02	0.00	.02	1.	1.01	14.30	87	.49	.47	.02	410.
1.01	.30	3	.02	0.00	.02	1.	1.01	14.40	88	.49	.47	.02	424.
1.01	.40	4	.02	0.00	.02	1.	1.01	14.50	89	.49	.47	.02	431.
1.01	.50	5	.02	0.00	.02	1.	1.01	15.00	90	.49	.47	.02	435.
1.01	1.00	6	.02	0.00	.02	1.	1.01	15.10	91	.45	.43	.02	433.
1.01	1.10	7	.02	0.00	.02	1.	1.01	15.20	92	.74	.73	.02	451.
1.01	1.20	8	.02	0.00	.02	1.	1.01	15.30	93	1.34	1.32	.02	578.
1.01	1.30	9	.02	0.00	.02	1.	1.01	15.40	94	3.34	3.32	.02	1005.
1.01	1.40	10	.02	0.00	.02	1.	1.01	15.50	95	.97	.95	.02	1522.
1.01	1.50	11	.02	0.00	.02	1.	1.01	16.00	96	.59	.58	.02	1477.
1.01	2.00	12	.02	0.00	.02	1.	1.01	16.10	97	.46	.44	.02	1080.
1.01	2.10	13	.02	0.00	.02	1.	1.01	16.20	98	.46	.44	.02	773.
1.01	2.20	14	.02	0.00	.02	1.	1.01	16.30	99	.46	.44	.02	596.
1.01	2.30	15	.02	0.00	.02	1.	1.01	16.40	100	.46	.44	.02	504.

1.01	2.40	16	.02	0.00	.02	1.	1.01	16.50	101	.46	.44	.02	458.
1.01	2.50	17	.02	0.00	.02	1.	1.01	17.00	102	.46	.44	.02	434.
1.01	3.00	18	.02	0.00	.02	1.	1.01	17.10	103	.36	.34	.02	412.
1.01	3.10	19	.02	0.00	.02	1.	1.01	17.20	104	.36	.34	.02	378.
1.01	3.20	20	.02	0.00	.02	1.	1.01	17.30	105	.36	.34	.02	348.
1.01	3.30	21	.02	0.00	.02	1.	1.01	17.40	106	.36	.34	.02	333.
1.01	3.40	22	.02	0.00	.02	1.	1.01	17.50	107	.36	.34	.02	325.
1.01	3.50	23	.02	0.00	.02	1.	1.01	18.00	108	.36	.34	.02	322.
1.01	4.00	24	.02	0.00	.02	1.	1.01	18.10	109	.03	.01	.02	288.
1.01	4.10	25	.02	0.00	.02	1.	1.01	18.20	110	.03	.01	.02	197.
1.01	4.20	26	.02	0.00	.02	1.	1.01	18.30	111	.03	.01	.02	111.
1.01	4.30	27	.02	0.00	.02	1.	1.01	18.40	112	.03	.01	.02	62.
1.01	4.40	28	.02	0.00	.02	1.	1.01	18.50	113	.03	.01	.02	38.
1.01	4.50	29	.02	0.00	.02	1.	1.01	19.00	114	.03	.01	.02	25.
1.01	5.00	30	.02	0.00	.02	1.	1.01	19.10	115	.03	.01	.02	19.
1.01	5.10	31	.02	0.00	.02	1.	1.01	19.20	116	.03	.01	.02	16.
1.01	5.20	32	.02	0.00	.02	1.	1.01	19.30	117	.03	.01	.02	14.
1.01	5.30	33	.02	0.00	.02	1.	1.01	19.40	118	.03	.01	.02	13.
1.01	5.40	34	.02	0.00	.02	1.	1.01	19.50	119	.03	.01	.02	13.
1.01	5.50	35	.02	0.00	.02	1.	1.01	20.00	120	.03	.01	.02	12.
1.01	6.00	36	.02	0.00	.02	1.	1.01	20.10	121	.03	.01	.02	12.
1.01	6.10	37	.06	0.00	.06	1.	1.01	20.20	122	.03	.01	.02	12.
1.01	6.20	38	.06	0.00	.06	1.	1.01	20.30	123	.03	.01	.02	12.
1.01	6.30	39	.06	0.00	.06	1.	1.01	20.40	124	.03	.01	.02	12.
1.01	6.40	40	.06	0.00	.06	1.	1.01	20.50	125	.03	.01	.02	12.
1.01	6.50	41	.06	0.00	.06	1.	1.01	21.00	126	.03	.01	.02	12.
1.01	7.00	42	.06	.04	.02	5.	1.01	21.10	127	.03	.01	.02	12.
1.01	7.10	43	.06	.04	.02	16.	1.01	21.20	128	.03	.01	.02	12.
1.01	7.20	44	.06	.04	.02	27.	1.01	21.30	129	.03	.01	.02	12.
1.01	7.30	45	.06	.04	.02	33.	1.01	21.40	130	.03	.01	.02	12.
1.01	7.40	46	.06	.04	.02	36.	1.01	21.50	131	.03	.01	.02	12.
1.01	7.50	47	.06	.04	.02	38.	1.01	22.00	132	.03	.01	.02	12.
1.01	8.00	48	.06	.04	.02	39.	1.01	22.10	133	.03	.01	.02	12.
1.01	8.10	49	.06	.04	.02	39.	1.01	22.20	134	.03	.01	.02	12.
1.01	8.20	50	.06	.04	.02	40.	1.01	22.30	135	.03	.01	.02	12.
1.01	8.30	51	.06	.04	.02	40.	1.01	22.40	136	.03	.01	.02	12.
1.01	8.40	52	.06	.04	.02	40.	1.01	22.50	137	.03	.01	.02	12.
1.01	8.50	53	.06	.04	.02	40.	1.01	23.00	138	.03	.01	.02	12.
1.01	9.00	54	.06	.04	.02	40.	1.01	23.10	139	.03	.01	.02	12.
1.01	9.10	55	.06	.04	.02	40.	1.01	23.20	140	.03	.01	.02	12.
1.01	9.20	56	.06	.04	.02	40.	1.01	23.30	141	.03	.01	.02	12.
1.01	9.30	57	.06	.04	.02	40.	1.01	23.40	142	.03	.01	.02	12.
1.01	9.40	58	.06	.04	.02	40.	1.01	23.50	143	.03	.01	.02	12.
1.01	9.50	59	.06	.04	.02	40.	1.02	0.00	144	.03	.01	.02	12.
1.01	10.00	60	.06	.04	.02	40.	1.02	.10	145	0.00	0.00	0.00	11.
1.01	10.10	61	.06	.04	.02	40.	1.02	.20	146	0.00	0.00	0.00	8.
1.01	10.20	62	.06	.04	.02	40.	1.02	.30	147	0.00	0.00	0.00	4.
1.01	10.30	63	.06	.04	.02	40.	1.02	.40	148	0.00	0.00	0.00	3.
1.01	10.40	64	.06	.04	.02	40.	1.02	.50	149	0.00	0.00	0.00	2.
1.01	10.50	65	.06	.04	.02	40.	1.02	1.00	150	0.00	0.00	0.00	1.
1.01	11.00	66	.06	.04	.02	40.	1.02	1.10	151	0.00	0.00	0.00	1.
1.01	11.10	67	.06	.04	.02	40.	1.02	1.20	152	0.00	0.00	0.00	1.
1.01	11.20	68	.06	.04	.02	40.	1.02	1.30	153	0.00	0.00	0.00	1.
1.01	11.30	69	.06	.04	.02	40.	1.02	1.40	154	0.00	0.00	0.00	1.
1.01	11.40	70	.06	.04	.02	40.	1.02	1.50	155	0.00	0.00	0.00	1.
1.01	11.50	71	.06	.04	.02	40.	1.02	2.00	156	0.00	0.00	0.00	1.
1.01	12.00	72	.06	.04	.02	40.	1.02	2.10	157	0.00	0.00	0.00	1.
1.01	12.10	73	.33	.31	.02	65.	1.02	2.20	158	0.00	0.00	0.00	1.
1.01	12.20	74	.33	.31	.02	138.	1.02	2.30	159	0.00	0.00	0.00	1.
1.01	12.30	75	.33	.31	.02	208.	1.02	2.40	160	0.00	0.00	0.00	1.

1.01	12.40	76	.33	.31	.02	247.	1.02	2.50	161	0.00	0.00	0.00	1.
1.01	12.50	77	.33	.31	.02	267.	1.02	3.00	162	0.00	0.00	0.00	1.
1.01	13.00	78	.33	.31	.02	277.	1.02	3.10	163	0.00	0.00	0.00	1.
1.01	13.10	79	.39	.37	.02	289.	1.02	3.20	164	0.00	0.00	0.00	1.
1.01	13.20	80	.39	.37	.02	309.	1.02	3.30	165	0.00	0.00	0.00	1.
1.01	13.30	81	.39	.37	.02	328.	1.02	3.40	166	0.00	0.00	0.00	1.
1.01	13.40	82	.39	.37	.02	338.	1.02	3.50	167	0.00	0.00	0.00	1.
1.01	13.50	83	.39	.37	.02	343.	1.02	4.00	168	0.00	0.00	0.00	1.
1.01	14.00	84	.39	.37	.02	346.	1.02	4.10	169	0.00	0.00	0.00	1.
1.01	14.10	85	.49	.47	.02	356.	1.02	4.20	170	0.00	0.00	0.00	1.
									SUM	23.41	20.69	2.72	19353.
										(595.)	(526.)	(69.)	(548.02)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1522.	480.	134.	114.	19340.
CMS	43.	14.	4.	3.	548.
INCHES		18.59	20.80	20.82	20.82
MM		472.20	528.41	528.91	528.91
AC-FT		238.	266.	266.	266.
THOUS CU M		293.	328.	329.	329.

HYDROGRAPH AT STA A3 FOR PLAN 1, RTIO 3

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	2.	8.	13.	17.	18.	19.	19.	20.	20.
20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	33.	69.	104.	124.	134.	139.	144.	155.
164.	169.	172.	173.	178.	192.	205.	212.	216.	218.
216.	225.	289.	502.	761.	733.	540.	386.	298.	252.
229.	217.	206.	189.	174.	166.	163.	161.	144.	99.
55.	31.	19.	13.	9.	8.	7.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	4.	2.	1.	1.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	761.	240.	67.	57.	9670.
CMS	22.	7.	2.	2.	274.
INCHES		9.30	10.40	10.41	10.41
MM		236.10	264.21	264.45	264.45
AC-FT		119.	133.	133.	133.
THOUS CU M		147.	164.	164.	164.

PLAN 2 SAME AS PLAN 1

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE A2 AND A3 HYDROGRAPHS

SUM OF 2 HYDROGRAPHS AT A4 PLAN 1 RTIO 3

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	8.	13.	19.	22.	24.	25.	29.	34.	38.
43.	47.	50.	54.	57.	59.	62.	64.	67.	69.
70.	72.	74.	75.	76.	78.	79.	80.	81.	81.
82.	83.	97.	140.	188.	227.	262.	293.	326.	363.
392.	432.	461.	488.	518.	557.	595.	629.	660.	688.
711.	743.	834.	1197.	1811.	2198.	2297.	2216.	2026.	1804.
1598.	1426.	1285.	1162.	1057.	973.	907.	856.	797.	699.
609.	561.	518.	479.	444.	411.	380.	352.	325.	301.
279.	259.	240.	223.	207.	192.	179.	167.	155.	145.
135.	127.	119.	111.	105.	98.	93.	87.	83.	78.
74.	70.	67.	64.	60.	56.	51.	47.	43.	40.
37.	34.	31.	29.	27.	25.	23.	21.	19.	18.
17.	15.	14.	13.	12.	11.	11.	10.	9.	9.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2297.	973.	307.	261.	44292.
CMS	65.	28.	9.	7.	1254.
INCHES		8.23	10.37	10.40	10.40
MM		209.05	263.36	264.27	264.27
AC-FT		483.	608.	610.	610.
THOUS CU M		595.	750.	753.	753.

AD-A087 536 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/13
NATIONAL DAM SAFETY PROGRAM, STAR LAKE UPPER DAM (NJ00221), DEL--ETC(U)
FEB 80 W GUINAN DACW61-79-C-0011

UNCLASSIFIED NL

2 OF 2

AD A087 536

END
DATE FILMED
9-80
DTIC

SUM OF 2 HYDROGRAPHS AT A4 PLAN 2 RTIO 3

6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	8.	13.	19.	22.	24.	25.	29.	34.	38.
43.	47.	50.	54.	57.	59.	62.	64.	67.	69.
70.	72.	74.	75.	76.	78.	79.	80.	81.	81.
82.	83.	97.	140.	188.	227.	262.	293.	326.	363.
399.	432.	461.	488.	518.	557.	595.	629.	660.	688.
711.	743.	834.	1197.	1811.	2198.	2297.	2216.	2026.	1804.
1598.	1426.	1285.	1162.	1057.	973.	907.	856.	797.	699.
609.	561.	518.	479.	444.	411.	380.	352.	325.	301.
279.	259.	240.	223.	207.	192.	179.	167.	155.	145.
135.	127.	119.	111.	105.	98.	93.	87.	83.	78.
74.	70.	67.	64.	60.	56.	51.	47.	43.	40.
37.	34.	31.	29.	27.	25.	23.	21.	19.	18.
17.	15.	14.	13.	12.	11.	11.	10.	9.	9.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2297.	973.	307.	261.	44292.
CMS	65.	28.	9.	7.	1254.
INCHES		8.23	10.37	10.40	10.40
MM		209.05	263.36	264.27	264.27
AC-FT		483.	608.	610.	610.
THOUS CU M		595.	750.	753.	753.

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HYDROGRAPH ROUTING

ROUTE INFLOW HYDROGRAPH THROUGH STAR LAKE RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A5	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	115.	-1

STAGE	529.90	531.00	531.60	532.10	532.60	533.70	535.00	
FLOW	0.00	174.00	334.00	629.00	1413.00	3245.00	7360.00	
CAPACITY=	0.	115.	136.	150.	165.	172.	197.	225.
ELEVATION=	522.	530.	531.	532.	532.	533.	534.	535.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
529.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
531.6	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
10.	1.00	521.60	1.00	529.90	531.60

STATION A5, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	2.	2.	3.	3.	3.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	6.	6.	6.	7.	7.	7.	7.
7.	8.	8.	8.	8.	8.	8.	9.	9.	9.
9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
10.	10.	10.	11.	13.	15.	18.	22.	26.	30.
35.	40.	45.	50.	55.	61.	66.	72.	78.	84.
90.	96.	102.	112.	127.	146.	163.	177.	192.	203.
211.	218.	223.	226.	227.	228.	227.	226.	223.	220.
214.	207.	200.	191.	183.	174.	167.	160.	153.	146.
139.	132.	125.	119.	112.	106.	100.	95.	89.	84.
79.	74.	70.	66.	62.	58.	54.	51.	48.	45.

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
15.833	0.000	376.	376.	0.	0.	0.
15.854	.021	397.	392.	5.	5.	0.
15.875	.042	419.	411.	8.	13.	0.
15.896	.063	440.	431.	9.	22.	0.
15.917	.083	461.	452.	9.	32.	0.
15.938	.104	482.	474.	8.	40.	0.
15.958	.125	504.	497.	6.	47.	0.
15.979	.146	525.	521.	4.	50.	0.
16.000	.167	546.	546.	0.	50.	0.
16.021	.188	572.	571.	0.	50.	0.
16.042	.208	598.	597.	0.	51.	0.
16.063	.229	623.	623.	0.	51.	0.
16.083	.250	649.	648.	1.	52.	0.
16.104	.271	675.	674.	1.	53.	0.
16.125	.292	700.	699.	1.	54.	0.
16.146	.313	726.	725.	1.	55.	0.
16.167	.333	752.	752.	0.	55.	0.
16.188	.354	778.	778.	-0.	55.	0.
16.208	.375	805.	805.	-1.	54.	0.
16.229	.396	831.	832.	-1.	53.	0.
16.250	.417	857.	859.	-2.	51.	0.
16.271	.438	884.	885.	-2.	49.	0.
16.292	.458	910.	911.	-1.	48.	0.
16.313	.479	937.	937.	-1.	47.	0.
16.333	.500	963.	963.	0.	47.	0.
16.354	.521	988.	989.	-1.	47.	0.
16.375	.542	1013.	1014.	-1.	46.	0.
16.396	.563	1038.	1039.	-1.	45.	0.
16.417	.583	1063.	1065.	-1.	44.	0.
16.438	.604	1088.	1090.	-1.	42.	0.
16.458	.625	1113.	1115.	-1.	41.	0.
16.479	.646	1139.	1139.	-1.	41.	0.
16.500	.667	1164.	1164.	-0.	41.	0.
16.521	.688	1192.	1189.	3.	44.	0.
16.542	.708	1220.	1218.	2.	46.	0.
16.563	.729	1248.	1247.	1.	46.	0.
16.583	.750	1276.	1276.	0.	47.	0.
16.604	.771	1304.	1305.	-0.	46.	0.
16.625	.792	1332.	1333.	-1.	46.	0.
16.646	.812	1361.	1361.	-0.	45.	0.
16.667	.833	1389.	1389.	0.	45.	0.
16.688	.854	1415.	1416.	-1.	44.	0.
16.708	.875	1441.	1443.	-2.	42.	0.
16.729	.896	1467.	1470.	-3.	39.	0.
16.750	.917	1493.	1496.	-3.	36.	0.
16.771	.937	1519.	1522.	-3.	33.	0.
16.792	.958	1545.	1548.	-2.	31.	0.
16.813	.979	1571.	1573.	-1.	29.	0.
16.833	1.000	1598.	1598.	0.	29.	0.

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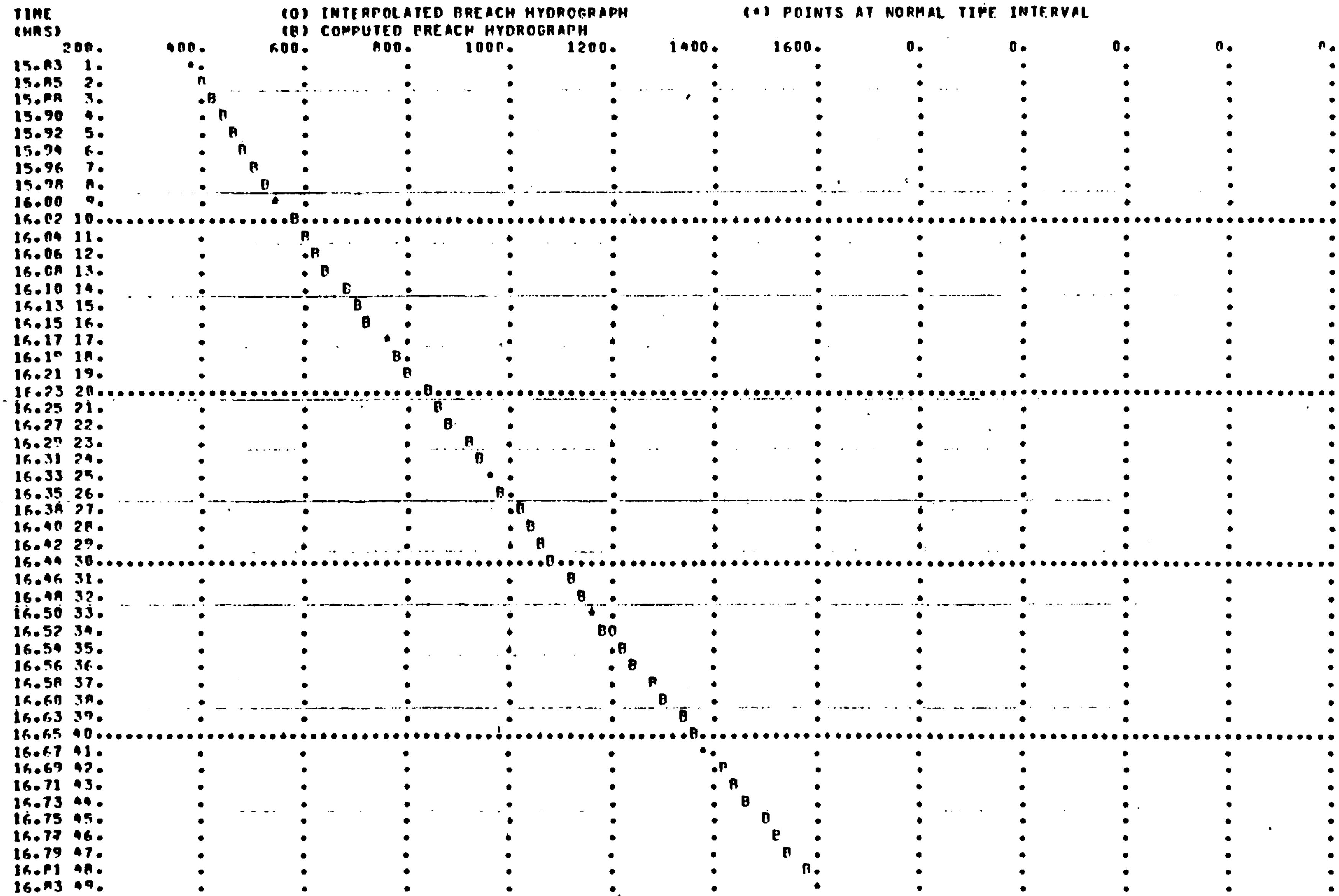
•OVF•

STATION A5



•CVN•

STATION A5, PLAN 1, RATIO 3

BEGIN DAM FAILURE AT 14.33 HOURS

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	2.	2.	3.	3.	3.	4.	4.	4.
4.	5.	5.	5.	5.	5.	5.	5.	5.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	7.	9.	10.	12.	13.	15.	18.
20.	23.	26.	28.	31.	34.	37.	40.	43.	45.
48.	50.	53.	55.	57.	59.	61.	63.	65.	67.
68.	70.	72.	77.	86.	99.	115.	133.	152.	173.
202.	234.	265.	295.	326.	371.	491.	669.	879.	1106.
1353.	1590.	1366.	1269.	1334.	1523.	1732.	1888.	1957.	1945.
1872.	1765.	1645.	1524.	1407.	1298.	1202.	1126.	1057.	988.
915.	846.	785.	729.	679.	633.	591.	553.	518.	485.
455.	427.	401.	377.	354.	333.	314.	296.	279.	264.
249.	235.	223.	211.	200.	190.	180.	171.	163.	155.
147.	141.	134.	128.	122.	117.	112.	107.	102.	97.
92.	88.	84.	80.	76.	73.	70.	66.	63.	60.
58.	55.	53.	50.	48.	46.	44.	42.	40.	39.

STORAGE

115.	115.	115.	115.	115.	115.	115.	115.	115.	116.
116.	116.	116.	116.	116.	116.	116.	116.	116.	116.
116.	116.	116.	116.	116.	116.	116.	116.	116.	116.
116.	116.	116.	116.	116.	116.	116.	116.	116.	116.
116.	116.	116.	116.	116.	116.	116.	117.	117.	117.
117.	118.	118.	118.	119.	119.	119.	120.	120.	120.
121.	121.	121.	122.	122.	122.	122.	123.	123.	123.
123.	123.	124.	124.	125.	127.	129.	131.	133.	136.
138.	141.	144.	147.	149.	152.	154.	154.	153.	148.
141.	131.	121.	117.	120.	128.	136.	143.	145.	145.
142.	138.	133.	128.	123.	118.	114.	110.	107.	103.
99.	95.	91.	87.	84.	81.	78.	75.	72.	70.
67.	65.	63.	60.	58.	56.	54.	53.	51.	49.
48.	46.	45.	43.	42.	41.	39.	38.	37.	36.
35.	34.	33.	32.	31.	30.	29.	29.	28.	27.
26.	26.	25.	24.	23.	23.	22.	21.	21.	20.
20.	19.	19.	18.	18.	17.	17.	16.	16.	15.

STAGE

529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	530.0	530.0	530.0	530.0	530.0	530.0
530.0	530.0	530.1	530.1	530.1	530.1	530.1	530.2	530.2	530.2
530.2	530.2	530.2	530.2	530.3	530.3	530.3	530.3	530.3	530.3
530.3	530.3	530.4	530.4	530.4	530.5	530.6	530.7	530.9	531.0
531.1	531.2	531.3	531.5	531.6	531.7	531.7	531.7	531.7	531.5
531.2	530.7	530.2	530.0	530.2	530.6	531.0	531.3	531.4	531.4
531.3	531.1	530.8	530.6	530.3	530.1	529.8	529.6	529.3	529.0
528.7	528.4	528.2	527.9	527.7	527.4	527.2	527.0	526.8	526.6
526.4	526.3	526.1	526.0	525.8	525.7	525.5	525.4	525.3	525.1

525.0	524.9	524.8	524.7	524.6	524.5	524.4	524.4	524.3	524.2
524.1	524.0	524.0	523.9	523.8	523.8	523.7	523.7	523.6	523.6
523.5	523.4	523.4	523.3	523.3	523.2	523.2	523.1	523.1	523.1
523.0	523.0	522.9	522.9	522.9	522.8	522.8	522.8	522.7	522.7

PEAK OUTFLOW IS 1957. AT TIME 16.50 HOURS

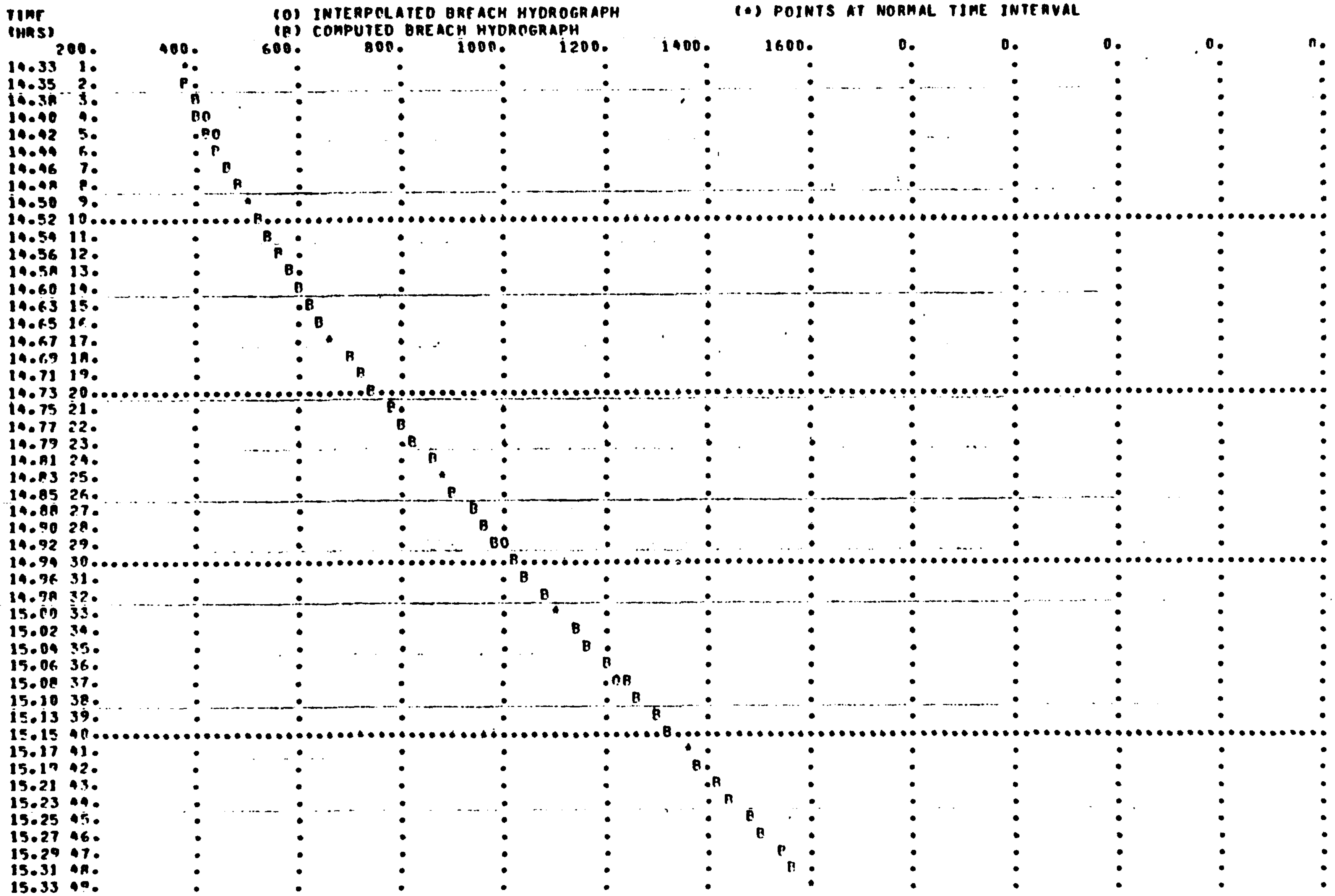
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1957.	1127.	357.	303.	51554.
CMS	55.	32.	10.	9.	1460.
INCHES		9.53	12.08	12.11	12.11
MM		242.10	306.95	307.61	307.61
AC-FT		559.	709.	710.	710.
THOUS CU M		689.	874.	876.	876.

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	- COMPUTED BREACH HYDROGRAPH (CFS)	= ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
14.333	0.000	371.	371.	0.	0.	0.
14.354	.021	386.	382.	5.	5.	0.
14.375	.042	401.	393.	8.	12.	0.
14.396	.063	416.	407.	9.	22.	0.
14.417	.083	431.	422.	10.	32.	0.
14.438	.104	446.	437.	9.	40.	0.
14.458	.125	461.	454.	7.	47.	0.
14.479	.146	476.	472.	4.	51.	0.
14.500	.167	491.	491.	0.	51.	0.
14.521	.188	513.	511.	3.	54.	0.
14.542	.208	536.	531.	4.	58.	0.
14.563	.229	558.	553.	5.	63.	0.
14.583	.250	580.	575.	5.	68.	0.
14.604	.271	602.	597.	5.	73.	0.
14.625	.292	625.	621.	4.	77.	0.
14.646	.313	647.	645.	2.	80.	0.
14.667	.333	669.	669.	-0.	80.	0.
14.688	.354	695.	694.	1.	81.	0.
14.708	.375	722.	720.	2.	83.	0.
14.729	.396	748.	746.	2.	85.	0.
14.750	.417	774.	772.	2.	87.	0.
14.771	.438	800.	799.	1.	88.	0.
14.792	.458	826.	826.	1.	89.	0.
14.813	.479	853.	852.	0.	89.	0.
14.833	.500	879.	879.	0.	89.	0.
14.854	.521	907.	905.	2.	91.	0.
14.875	.542	936.	932.	3.	94.	0.
14.896	.563	964.	959.	5.	99.	0.
14.917	.583	992.	986.	6.	104.	0.
14.938	.604	1021.	1014.	7.	112.	0.
14.958	.625	1049.	1044.	5.	117.	0.
14.979	.646	1078.	1075.	3.	120.	0.
15.000	.667	1106.	1106.	-0.	120.	0.
15.021	.688	1137.	1137.	-0.	119.	0.
15.042	.708	1168.	1168.	-0.	119.	0.
15.063	.729	1199.	1199.	-1.	118.	0.
15.083	.750	1230.	1230.	-1.	118.	0.
15.104	.771	1260.	1261.	-1.	117.	0.
15.125	.792	1291.	1292.	-1.	117.	0.
15.146	.812	1322.	1323.	-0.	116.	0.
15.167	.833	1353.	1353.	0.	116.	0.
15.188	.854	1383.	1384.	-1.	115.	0.
15.208	.875	1412.	1414.	-1.	114.	0.
15.229	.896	1442.	1443.	-1.	113.	0.
15.250	.917	1472.	1473.	-1.	111.	0.
15.271	.937	1501.	1503.	-2.	110.	0.
15.292	.958	1531.	1532.	-1.	108.	0.
15.313	.979	1561.	1561.	-1.	107.	0.
15.333	1.000	1590.	1590.	0.	107.	0.

•OVF•

STATION A5



DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
10.	1.00	521.60	1.00	529.90	550.00

STATION A5, PLAN 2, RATIO 1

STATION A5, PLAN 2, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	1.	2.	2.	3.	3.	3.	4.	4.	4.
4.	5.	5.	5.	5.	5.	5.	5.	5.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	7.	9.	10.	12.	13.	15.	18.
20.	23.	26.	28.	31.	34.	37.	40.	43.	45.
48.	50.	53.	55.	57.	59.	61.	63.	65.	67.
68.	70.	72.	77.	86.	99.	115.	133.	152.	173.
202.	234.	265.	295.	326.	371.	420.	466.	508.	548.
584.	618.	738.	980.	1431.	1816.	2106.	2206.	2149.	1992.
1797.	1606.	1438.	1257.	1129.	1030.	952.	890.	834.	759.
668.	620.	601.	576.	549.	520.	490.	460.	431.	403.
376.	351.	329.	315.	300.	286.	271.	257.	243.	229.
216.	204.	192.	181.	171.	164.	156.	149.	142.	135.
129.	123.	117.	112.	106.	101.	96.	91.	86.	81.
77.	72.	68.	64.	60.	56.	53.	50.	46.	43.
41.	38.	35.	33.	31.	29.	27.	25.	23.	22.

STORAGE

115.	115.	115.	115.	115.	115.	115.	115.	115.	116.
116.	116.	116.	116.	116.	116.	116.	116.	116.	116.

116.	116.	116.	116.	116.	116.	116.	116.	116.	116.
116.	116.	116.	116.	116.	116.	116.	116.	116.	116.
116.	116.	116.	116.	116.	116.	116.	117.	117.	117.
117.	118.	118.	118.	119.	119.	119.	120.	120.	120.
121.	121.	121.	122.	122.	122.	122.	123.	123.	123.
123.	123.	124.	124.	125.	127.	129.	131.	133.	136.
138.	141.	144.	147.	149.	152.	154.	157.	159.	161.
163.	164.	166.	168.	172.	177.	181.	183.	182.	180.
177.	175.	172.	171.	169.	169.	168.	167.	167.	166.
165.	165.	164.	162.	161.	159.	158.	156.	155.	154.
152.	151.	150.	148.	147.	146.	144.	143.	142.	141.
140.	139.	138.	137.	136.	135.	134.	133.	132.	131.
131.	130.	129.	128.	128.	127.	127.	126.	125.	125.
124.	124.	123.	123.	122.	122.	121.	121.	121.	120.
120.	120.	119.	119.	119.	118.	118.	118.	118.	118.

STAGE

529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9	529.9
529.9	529.9	529.9	529.9	530.0	530.0	530.0	530.0	530.0	530.0
530.0	530.0	530.1	530.1	530.1	530.1	530.1	530.2	530.2	530.2
530.2	530.2	530.2	530.2	530.3	530.3	530.3	530.3	530.3	530.3
530.3	530.3	530.4	530.4	530.4	530.5	530.6	530.7	530.9	531.0
531.1	531.2	531.3	531.5	531.6	531.7	531.7	531.8	531.9	532.0
532.0	532.1	532.2	532.3	532.6	532.8	533.0	533.1	533.0	532.9
532.8	532.7	532.6	532.5	532.4	532.4	532.3	532.3	532.2	532.2
532.1	532.1	532.1	532.0	532.0	531.9	531.9	531.8	531.8	531.7
531.7	531.6	531.6	531.5	531.5	531.4	531.4	531.3	531.3	531.2
531.2	531.1	531.1	531.0	531.0	530.9	530.9	530.8	530.8	530.8
530.7	530.7	530.6	530.6	530.6	530.5	530.5	530.5	530.4	530.4
530.4	530.4	530.3	530.3	530.3	530.3	530.2	530.2	530.2	530.2
530.2	530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.0	530.0

PEAK OUTFLOW IS 2206. AT TIME 16.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2206.	953.	306.	259.	44109.
CMS	62.	27.	9.	7.	1249.
INCHES		8.06	10.34	10.36	10.36
MM		204.72	262.53	263.18	263.18
AC-FT		473.	606.	608.	608.
THOUS CU M		583.	748.	749.	749.

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HYDROGRAPH ROUTING

ROUTE BREACH OUTFLOW HYDROGRAPH THROUGH STAR LAKE LOWER RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A6	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	50.	-1

STAGE	524.10	524.20	525.30	526.00	526.20	527.00	
FLOW	0.00	2.00	163.00	410.00	475.00	2070.00	
CAPACITY=	0.	50.	52.	54.	56.	57.	60.
ELEVATION=	509.	524.	524.	525.	526.	526.	527.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
524.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
525.3	0.0	0.0	0.

STATION A6, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
2.	2.	2.	2.	2.	2.	2.	5.	5.	6.
6.	6.	6.	7.	8.	9.	10.	12.	14.	16.

18.	20.	23.	26.	29.	32.	34.	37.	40.	43.
45.	48.	51.	53.	55.	57.	60.	62.	63.	65.
67.	68.	70.	73.	79.	89.	102.	118.	135.	154.
182.	215.	246.	277.	308.	345.	420.	587.	881.	1056.
1329.	1553.	1435.	1251.	1331.	1484.	1709.	1867.	1954.	1950.
1885.	1781.	1662.	1541.	1423.	1313.	1215.	1135.	1066.	997.
926.	855.	793.	736.	686.	639.	597.	558.	522.	489.
471.	452.	428.	401.	368.	346.	325.	307.	289.	273.
258.	243.	230.	218.	206.	196.	186.	176.	168.	160.
154.	147.	140.	134.	128.	122.	116.	111.	106.	101.
97.	92.	88.	84.	80.	76.	73.	70.	66.	63.
60.	58.	55.	53.	50.	48.	46.	44.	42.	40.

STORAGE

50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
50.	50.	50.	50.	51.	51.	51.	51.	51.	51.
51.	51.	51.	51.	51.	51.	51.	51.	51.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	54.	54.
54.	54.	55.	55.	55.	55.	56.	57.	58.	58.
59.	59.	59.	58.	59.	59.	59.	60.	60.	60.
60.	59.	59.	59.	59.	59.	58.	58.	58.	58.
58.	58.	58.	57.	57.	57.	57.	57.	57.	57.
57.	57.	56.	56.	56.	55.	55.	55.	55.	55.
55.	55.	55.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	52.	52.

STAGE

524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1
524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1
524.1	524.1	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2
524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2
524.2	524.2	524.2	524.2	524.2	524.2	524.3	524.3	524.3	524.3
524.3	524.3	524.3	524.4	524.4	524.4	524.4	524.4	524.5	524.5
524.5	524.5	524.5	524.5	524.6	524.6	524.6	524.6	524.6	524.6
524.6	524.7	524.7	524.7	524.7	524.8	524.9	525.0	525.1	525.2
525.4	525.4	525.5	525.6	525.7	525.8	526.0	526.3	526.4	526.5
526.6	526.7	526.7	526.6	526.6	526.7	526.8	526.9	526.9	526.9
526.9	526.9	526.8	526.7	526.7	526.6	526.6	526.5	526.5	526.5
526.4	526.4	526.4	526.3	526.3	526.3	526.3	526.2	526.2	526.2
526.2	526.1	526.1	526.0	525.9	525.8	525.8	525.7	525.7	525.6
525.6	525.5	525.5	525.5	525.4	525.4	525.4	525.3	525.3	525.3
525.2	525.2	525.1	525.1	525.1	525.0	525.0	524.9	524.9	524.9
524.8	524.8	524.8	524.8	524.7	524.7	524.7	524.7	524.6	524.6
524.6	524.6	524.6	524.5	524.5	524.5	524.5	524.5	524.5	524.5

PEAK OUTFLOW IS 1954. AT TIME 16.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1954.	1126.	357.	302.	51381.
CMS	55.	32.	10.	9.	1455.
INCHES		9.53	12.07	12.07	12.07
MM		241.96	306.50	306.57	306.57
AC-FT		557.	708.	708.	708.
THOUS CU M		689.	873.	873.	873.

STATION A6, PLAN 2, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
2.	2.	2.	2.	2.	2.	2.	5.	5.	6.
6.	6.	6.	7.	8.	9.	10.	12.	14.	16.
18.	20.	23.	26.	29.	32.	34.	37.	40.	43.
45.	48.	51.	53.	55.	57.	60.	62.	63.	65.
67.	68.	70.	73.	79.	89.	102.	118.	135.	154.
182.	215.	246.	277.	308.	345.	391.	429.	465.	549.
576.	615.	714.	942.	1356.	1776.	2066.	2207.	2161.	2019.
1823.	1632.	1459.	1285.	1142.	1044.	960.	898.	842.	771.
681.	623.	603.	580.	553.	524.	494.	472.	456.	432.
404.	367.	342.	324.	309.	294.	280.	265.	251.	237.
224.	211.	199.	187.	177.	168.	162.	155.	148.	142.
135.	129.	122.	117.	111.	106.	101.	96.	91.	86.
81.	76.	72.	66.	64.	60.	56.	53.	50.	46.
43.	41.	38.	35.	33.	31.	29.	27.	25.	23.

STORAGE

50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
50.	50.	50.	50.	51.	51.	51.	51.	51.	51.
51.	51.	51.	51.	51.	51.	51.	51.	51.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	52.

52.	52.	52.	52.	52.	52.	52.	52.	52.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	54.	54.
54.	54.	55.	55.	55.	55.	56.	56.	57.	57.
57.	57.	57.	58.	59.	59.	60.	60.	60.	60.
60.	59.	59.	59.	58.	58.	58.	58.	58.	58.
57.	57.	57.	57.	57.	57.	57.	57.	57.	56.
56.	56.	55.	55.	55.	55.	55.	55.	55.	55.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	52.	52.	52.	52.	52.	52.	52.	52.	52.

STAGE

524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1
524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1	524.1
524.1	524.1	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2
524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2	524.2
524.2	524.2	524.2	524.2	524.2	524.2	524.3	524.3	524.3	524.3
524.3	524.3	524.3	524.4	524.4	524.4	524.4	524.4	524.5	524.5
524.5	524.5	524.5	524.5	524.6	524.6	524.6	524.6	524.6	524.6
524.6	524.7	524.7	524.7	524.7	524.8	524.9	525.0	525.1	525.2
525.4	525.4	525.5	525.6	525.7	525.8	525.9	526.1	526.2	526.2
526.3	526.3	526.3	526.4	526.6	526.9	527.0	527.1	527.0	527.0
526.9	526.8	526.7	526.6	526.5	526.5	526.4	526.4	526.4	526.3
526.3	526.3	526.3	526.3	526.2	526.2	526.2	526.2	526.1	526.1
526.0	525.9	525.8	525.8	525.7	525.7	525.6	525.6	525.5	525.5
525.5	525.4	525.4	525.4	525.3	525.3	525.3	525.2	525.2	525.2
525.1	525.1	525.0	525.0	524.9	524.9	524.9	524.8	524.8	524.8
524.7	524.7	524.7	524.6	524.6	524.6	524.6	524.5	524.5	524.5
524.5	524.5	524.4	524.4	524.4	524.4	524.4	524.4	524.4	524.3

PEAK OUTFLOW IS 2207. AT TIME 16.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2207.	953.	305.	259.	43951.
CMS	63.	27.	9.	7.	1245.
INCHES		8.06	10.32	10.32	10.32
MM		204.65	262.17	262.24	262.24
AC-FT		472.	605.	605.	605.
THOUS CU M		583.	747.	747.	747.

....

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .10	RATIO 2 .25	RATIO 3 .50
						RATIOS APPLIED TO FLOWS
HYDROGRAPH AT	A1	.86	1	488.	1219.	2438.
		(2.23)		(13.81)(	34.52)(	69.04)(
			2	488.	1219.	2438.
				(13.81)(	34.52)(	69.04)(
ROUTED TO	A2	.86	1	215.	539.	1830.
		(2.23)		(6.09)(	15.26)(	51.82)(
			2	215.	539.	1830.
				(6.09)(	15.26)(	51.82)(
HYDROGRAPH AT	A3	.24	1	152.	380.	761.
		(.62)		(4.31)(	10.77)(	21.55)(
			2	152.	380.	761.
				(4.31)(	10.77)(	21.55)(
2 COMBINED	A4	1.10	1	309.	776.	2297.
		(2.85)		(8.76)(	21.96)(	65.05)(
			2	309.	776.	2297.
				(8.76)(	21.96)(	65.05)(
ROUTED TO	A5	1.10	1	228.	1598.	1957.
		(2.85)		(6.45)(	45.24)(	55.43)(
			2	228.	643.	2206.
				(6.45)(	18.21)(	62.48)(
ROUTED TO	A6	1.10	1	227.	1570.	1954.
		(2.85)		(6.44)(	44.47)(	55.33)(
			2	227.	645.	2207.
				(6.44)(	18.27)(	62.50)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	530.60	530.60	534.00
STORAGE	210.	210.	300.
OUTFLOW	6.	6.	563.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	531.88	0.00	244.	215.	0.00	16.67	0.00
.25	533.85	0.00	296.	539.	0.00	16.67	0.00
.50	535.22	1.22	343.	1830.	2.83	16.33	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	530.60	530.60	534.00
STORAGE	210.	210.	300.
OUTFLOW	6.	6.	563.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	531.88	0.00	244.	215.	0.00	16.67	0.00
.25	533.85	0.00	296.	539.	0.00	16.67	0.00
.50	535.22	1.22	343.	1830.	2.83	16.33	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	529.90	529.90	531.60
STORAGE	115.	115.	150.
OUTFLOW	0.	0.	334.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	531.20	0.00	141.	228.	0.00	17.67	0.00
.25	531.85	.25	158.	1598.	.83	16.83	15.83
.50	531.74	.14	154.	1957.	.77	16.50	14.33

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	529.90	529.90	531.60
STORAGE	115.	115.	150.
OUTFLOW	0.	0.	334.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	531.20	0.00	141.	228.	0.00	17.67	0.00
.25	532.11	.51	165.	643.	4.00	17.00	0.00
.50	533.08	1.48	183.	2206.	6.17	16.33	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	524.10	524.10	525.30
STORAGE	50.	50.	54.
OUTFLOW	0.	0.	163.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	525.48	.18	55.	227.	3.50	17.83	0.00
.25	526.75	1.45	59.	1570.	7.83	16.83	0.00
.50	526.94	1.64	60.	1954.	9.83	16.50	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	524.10	524.10	525.30
STORAGE	50.	50.	54.
OUTFLOW	0.	0.	163.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	525.48	.18	55.	227.	3.50	17.83	0.00
.25	526.29	.99	57.	645.	7.33	17.00	0.00
.50	527.07	1.77	60.	2207.	9.33	16.33	0.00

APPENDIX 4

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